THE IMPACT OF MEDICAL EDUCATION REFORM ON THE TEACHING AND LEARNING OF THE ANATOMICAL SCIENCES

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DEDICATION

To my mom, Maggie and my dad, Kevin. Thank you so much for supporting me during my education, and especially these last six years in my PhD program. To my teachers and mentors throughout all my years of schooling, I could not have done this without you. And lastly, thank you to my cat, Seamus who always gives me cuddles whenever needed.

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THE IMPACT OF MEDICAL EDUCATION REFORM ON THE TEACHING AND LEARNING OF THE ANATOMICAL SCIENCES

Curricular reform in medical education is a process that has been ongoing for quite some time. Major revision of medical curricula has been occurring since the early eighteenth century. In recent decades, curricular reform has had a monumental impact on the anatomical science subjects. This research investigated how specifically the anatomical science disciplines were impacted by curricular reform at various allopathic medical schools within the United States. The goal of this research was to discover curricular variations in medical schools and to examine the perceptions of those curricular programs by faculty and students alike. Four research questions were addressed to explore the role of curricular reform in medical education using a mixed methods study design. Medical curricular websites were qualitatively analyzed to discover common trends used to describe medical curricula and content organization. Perceptions about the medical curriculum were gathered through surveys and interviews of anatomical science faculty across the country and first year medical students at Indiana University School of Medicine-Bloomington. Finally, a case study of curricular changes at Indiana University School of Medicine was documented. Results from this research demonstrated that curricular reform has had a major impact on the anatomical disciplines. Didactic lectures have been supplemented or replaced by non-didactic teaching tools. Hours dedicated to the teaching of the anatomical sciences have greatly decreased, and most anatomical disciplines are no longer taught as stand-alone courses. Qualitative results discovered that

there is an overall administrative control of the medical curriculum. Additional perceptual data demonstrated the need for measuring student success past the licensing exam scores. There’s a need for future studies to further analyze student success regarding lifelong learning, problem-solving, and critical thinking skills.

Valerie Dean O’Loughlin, Ph.D., Chair

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LIST OF ABBREVIATIONS

AAA:	American Association of Anatomists
AACA:	American Association of Clinical Anatomists
AACBNC:	Association of Anatomy, Cell Biology and Neurobiology Chairpersons
AAMC:	Association of American Medical Colleges
ACME-TRI:	Assessing Change in Medical Education – The Road to Implementation
AMA:	American Medical Association
CME:	Continuing Medical Education
CP:	Clinical Presentation
GME:	Graduate Medical Education
GPEP:	General Professional Education of the Physician
GRAT:	Group Readiness Assessment Test
HAPS:	Human Anatomy and Physiology Society
IRAT:	Individual Readiness Assessment Test
IUSM:	Indiana University School of Medicine
IUSM-B:	Indiana University School of Medicine-Bloomington
LCME:	Liaison Committee on Medical Education
MCAT:	Medical College Admission Test
MD:	Medical Doctorate
NBME:	National Board of Medical Examiners
PBL:	Problem-based learning
SDL:	Self-directed learning
SLO:	Session Learning Objective

SPSS: Statistical Package for the Social Sciences

SRL: Self-regulated learning

TBL: Team-based learning

TPS: Total population sampling

UCSF: University of California-San Francisco

UME: Undergraduate medical education

USMLE: United States Medical Licensing Examinations

CHAPTER 1: INTRODUCTION

The anatomical sciences (gross anatomy, microscopic anatomy, and neuroanatomy) represent a cornerstone of medical education. As medical education evolves, so must the anatomical science disciplines. This dissertation examines the effects of medical education reform on the teaching and learning of the anatomical sciences.

Medical education in the United States has been changing dramatically in the last three decades. Medical schools are moving away from a traditional, didactic, and discipline-based curriculum, to a more integrative, active, and student-centered curriculum (Cooke et al., 2010). However, before medical schools even utilized the traditional, didactic curriculum, there were other curricular models which medical schools followed (Ludmerer, 1985).

In the United States, medical education began with the apprenticeship model during the colonial era, and that model remained until around the mid-1800s (Ludmerer, 1985). In this curricular model, students studied with a physician who served as their preceptor. The preceptor would train the students for 3-4 years, including lessons in anatomy, physiology, chemistry, and pharmacy. Once the students mastered that knowledge, they would make house calls with the physician to learn how to treat patients (Robinson, 1957; Rothstein, 1973). This curricular model continued even when formal medical institutions began in the late 1700s. However, it all but disappeared in the mid-1800s due to indeterminable factors, but possibly due to the rise in formal medical schools in the United States during that time.

Medical Education in the United States and Canada: A Report to the Carnegie Foundation for the Advancement of Teaching, (more commonly known as the "Flexner Report") was a report written by Abraham Flexner in the early 1900s, after the replacement of apprenticeship medical education with formal medical institutions (Flexner, 1910). This report called for higher admission and graduation standards of the medical students. It also recommended expanding the length of medical school to four years in total. The findings of the report resulted in many of the 155 medical schools which existed during the early 1900s to be closed or merged with other medical schools (Flexner, 1910). By 1928, there were only 76 remaining medical schools in the US and Canada (Chapman, 1974).

One of the primary recommendations that Flexner proposed was the separation of the basic science years and the clinical years of medical school. Basic science courses, (e.g., gross anatomy, histology, pathology, medicine), Flexner stated, should be taught in the first two years of medical school, and the clinical sciences (clerkships and electives in surgery, obstetrics and gynecology, internal medicine, etc.) should be in the last two years of medical school. This is now commonly referred to as the "2+2" medical curriculum (Cooke et al., 2010).

However, this traditional curricular model has been deconstructed in recent years and has given rise to more modern forms of medical curricula (Cooke et al., 2010; McBride & Drake, 2018). Modern medical curricula now combine previously independent subjects to create consolidated courses where the basic and clinical sciences are taught concurrently (Brooks et al., 2015; Eisenstein et al., 2014; Klement et al., 2017), oftentimes referred to as "integrated" curricula. Despite multiple studies that published on medical curricular reform, these more integrated curricula are not without their limitations. Questions still remain as to how specifically medical education reform has impacted medical curricula across the country (not just at one institution), especially with regard to the anatomical science subjects.

Definitions from this Research

Since the meaning of integration varies widely across the literature and is used in different manners by various medical schools, the author decided a strict definition of the term was needed. However, before defining integration, it is important to define what curriculum is. Additionally, it is necessary to define the different types of medical curricula that are utilized by medical schools throughout the country. **Curriculum** may be defined as "all the learning which is planned and guided by the school, whether it is carried on in groups or individually, inside or outside the school" (Kerr, 1967, pg.6).

The "2+2" curricular model mentioned above is referred to as the **traditional curriculum** (Flexner, 1910; Papa and Harasym, 1999). This model may also be referred to as the **discipline-based model**, where courses are taught by their separate disciplines (Papa and Harasym, 1999). Other medical curricular models that schools in the United States follow include a **problem-based model** (courses taught through clinical cases), an **organ systems-based model** (courses taught by organ systems), and a **clinical presentation model** (courses taught through clinical cases, but through the ways the patients present to a physician) (Hecker and Violato, 2008; Papa and Harasym, 1999). There may also be great variance in these curricular models. One school may have a discipline-based approach the first year of medical school, while the second year may have an organ-systems approach. Or the school may have a mix of discipline and organ-systems approaches. There is no "one size fits all" approach to medical education.

Medical schools may also refer to their curriculum as "integrated." There is no one definition for an integrated curriculum that all medical schools have adopted. The definition for **integration** that is used for this research is from Harden et al. (1984): "the organization of teaching matter to interrelate or unify subjects frequently taught in separate academic courses or departments" (pg. 288).

There are also different forms that an integrated curriculum can take, such as horizontal integration, vertical integration, or spiral integration (Brauer and Ferguson, 2015). These terms, defined by the author, adapted from Brauer and Ferguson (2015) are as follows:

- **Horizontal integration** is integration across disciplines but only for a certain period of time (and typically within a single year of coursework). An example of this is combining the basic science courses together into one block during the first-year of medical school.
- **Vertical integration** is integration across time (typically over multiple years), such as integrating anatomy into clerkships and electives within years 3 and 4 of medical school, rather than just teaching anatomy in year 1.
- **Spiral integration** is a combination of horizontal and vertical integration. Here, basic and clinical sciences interact at all phases of medical school; they build upon each other. For a fully spirally integrated curriculum, Brauer and Ferguson use the definition "a fully synchronous, trans-disciplinary delivery of information between the foundational sciences and the applied sciences throughout all years of a medical school curriculum" (pg. 318).

Many medical schools in the United States, when they have shifted from a traditional curricular model to another curricular model (such as a problem-based learning model), or if they have integrated their curriculum, have undergone **curricular reform**. Curricular reform may include changing curriculum content, curriculum delivery, or curricular design, or by implementing all three aspects to implement a complete curricular change (Jones et al., 2001).

There are many reasons why a medical school may revise its curriculum. One possible reason is to meet medical education standards set forth by the Liaison Committee on Medical Education (LCME). This organizational committee, created in 1948, is the accrediting agency for all medical schools in the US and Canada that grant a medical doctorate (MD) degree. The organization implements standards that medical schools must adhere to in order to receive accreditation (LCME, 2018).

In order to meet some of the standards set forth by the LCME (see subsection *Curricular Reform after Flexner* in Chapter 2 for an overview of the twelve LCME standards), many medical schools have reduced the number of course hours dedicated to the teaching of the basic sciences, including the anatomical sciences. This reduction in course hours allows for the inclusion of other aspects of medical education, such as earlier clinic visits and patient interactions (Cooke et al., 2010). Reduction of course hours in the **anatomical sciences** (gross anatomy, microscopic anatomy, and neuroanatomy) was specifically noted by Drake and his colleagues in four separate surveys of medical schools in the United States (Drake et al., 2002, 2009, and 2014; McBride and Drake, 2018). Yet while the reduction of hours in the teaching of anatomy has been noted, the specific impacts of these reduced hours on teaching anatomy has yet to be thoroughly explored.

Statement of the Problem

Curricular reform in medical schools in the United States has been a more common occurrence in the last few decades, especially with the handling of the teaching and learning of anatomical disciplines. It is important to know the reasons behind the curricular reform, what specific changes the medical schools have undergone, and the resulting effects of reform on faculty and student perceptions of their medical education. Many researchers who have conducted studies on curricular reform in medical schools have only reported on the changes to their own medical institution (e.g., Brooks et al., 2015; Klement et al., 2017; Lazarus et al., 2014). Additionally, there have only been a few studies that have looked at multiple institutions (Cuddy et al., 2013; McBride and Drake, 2018; Hecker and Violato, 2009), and these studies only reported on one or two aspects of medical curricular reform at the medical schools. Thus, the global effects of medical curricular reform on the teaching and learning of the anatomical sciences have not been thoroughly researched and explored. This dissertation research seeks to fill these gaps in the literature by providing a comprehensive and systematic evaluation of US medical curricular reform and its impact on the teaching and learning of the anatomical sciences. This research begins with a global overview and classification of different US medical schools' curricular reform, and then examines data from anatomy faculty and medical students about the perceived impacts of this reform on the teaching of anatomy.

Research Purpose and Questions

This research studies the impact of medical curricular reform on the anatomical science disciplines in the United States. It is the aim of this project to discover curricular variations in medical schools and to examine the perceptions of those curricular programs by faculty and students alike.

The four research questions for this dissertation follow. For the hypotheses and rationale of these research questions, please see Chapter 3.

1. How do American medical schools granting a medical doctorate degree classify their curricula?
2. See below
   a. What number of allopathic medical schools in the United States have undergone any major curricular reform within the last 10 years (since 2007)?
   b. What were the medical schools' stated reasons for curricular reform at their institutions?
3. How are anatomical science classes organized within medical school curricula that have been recently revised?
   a. Does the anatomy content coverage increase, decrease or stay the same for classes involving the anatomical sciences?
   b. How does the curricular revision change the amount of anatomy lab experience and type of lab experience in the anatomical sciences?
   c. How does the curricular revision change the anatomy lecture experience in the anatomical sciences?
   d. What are faculty perceptions of curricular reform at their institution?
4. What are medical student and faculty perceptions of curricular reform at a case study institution (Indiana University School of Medicine-Bloomington or IUSM-B), and how do they compare to the US landscape?
   a. How do first-year medical students at IUSM-B perceive the newly implemented medical curriculum that began in fall 2016?

b. How do anatomy faculty perceptions of curricular reform at IUSM-B compare to anatomy faculty perceptions from other US medical schools?

Dissertation Outline and Methodologies

To investigate the research questions, this dissertation encompasses seven chapters. Chapter 1 has introduced the need for this research. Chapter 2 presents a detailed review of the literature surrounding the history of medical education reform in the United States. Chapter 3 reiterates the research questions that formed the foundation for this dissertation investigation. This chapter also presents the proposed hypotheses and rationales accompanying the research questions, in addition to a meticulous description of the methodology employed to investigate each research question.

The results of this research, seen in Chapters 4, 5, and 6 utilize mixed methodology (Bergman, 2008). This type of methodology encompasses both quantitative measures of data analysis, where numerical data is collected and analyzed using statistical measures, and qualitative measures of data analysis, where language is analyzed to look for patterns and themes. The specific measures of both quantitative and qualitative data analysis are mentioned in the following chapters of results from this dissertation.

Chapter 4 of this research covers the results of a website analysis of all allopathic medical schools in the United States and helps to answer research question 1. This chapter is the first of three results chapters. In this results section, the author utilizes a qualitative methodology called content analysis which is used to tally the frequencies of key terms found from medical curricular websites. The author uses the data from the content analysis to develop a new curricular classification model that medical schools can follow to both classify and design their own curricula. This new model expands upon earlier work of Papa and Harasym (1999) and incorporates a nuanced and complete description of the different types of integration in medical curricula. It is the author's hope that this model will be adopted by other researchers and medical schools, so that comparative discussions about medical curricular reform may be done.

Chapter 5 presents the quantitative analysis from faculty surveys, as well as qualitative analysis from open-ended survey questions and faculty interviews. This chapter helps answer research questions 2 and 3. The quantitative statistical methods used in this chapter include descriptive statistics, frequencies, Spearman's correlation coefficient, Chi square test of independence, Mann-Whitney U, and Kruskal-Wallis tests. For the qualitative analysis of the open-ended survey questions, content analysis is used. For the faculty interview analysis, a qualitative methodology called thematic analysis is used to discover recurring themes with the data.

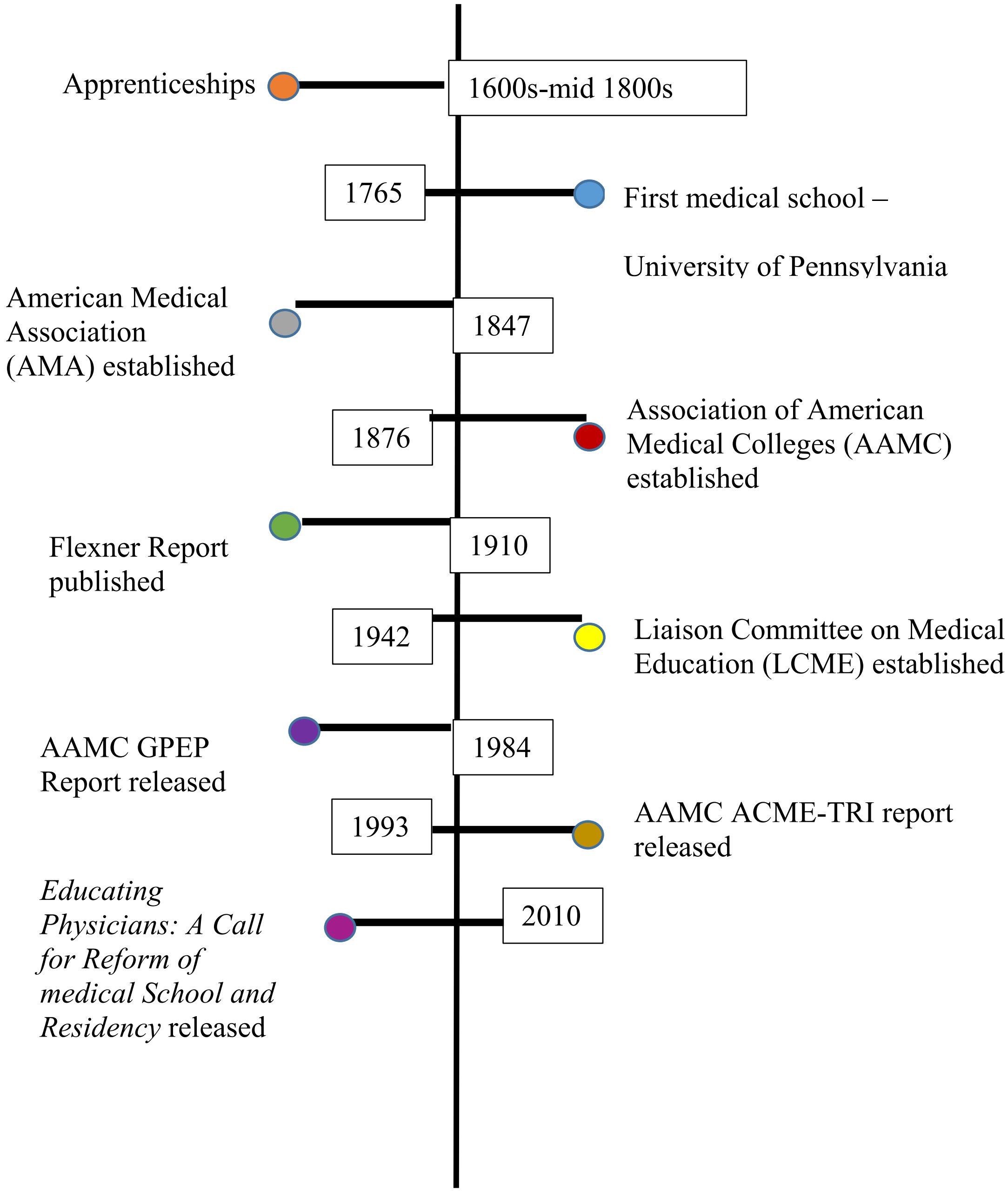
Chapter 6 begins with a case study analysis of the medical curriculum at Indiana University School of Medicine-Bloomington campus (IUSM-B), which underwent major curricular reform in fall 2016. How specifically the anatomical science courses changed as a result of curricular reform is discussed. Also in this chapter, results and analysis of IUSM-B first-year medical student surveys and focus group are presented. Finally, results from a focus group on anatomical science faculty at IUSM-B are analyzed. For the medical student surveys, descriptive statistics are the only measures used to analyze the quantitative survey data due to the low sample size of the student participants. Content analysis is used to analyze the open-ended survey responses. For the two focus group sessions, thematic analysis is used to analyze the data.

The final chapter of this dissertation, Chapter 7, synthesizes all the previous components of the research study and forms evidence-based recommendations regarding medical education reform and the teaching and learning of the anatomical sciences. This chapter also outlines limitations of the research and presents ideas for future directions of this research.

CHAPTER 2: REVIEW OF LITERATURE

This chapter is a review of the literature about medical curricular reform, with special regard to the anatomical sciences. Before discussing reform, it is necessary to discuss the history of medical education in the United States, from apprenticeships to the rise of formal medical education. Next, early medical curricular reform, including the Flexner Report is discussed. The Flexner report's impact on subsequent curricular reform and different curricular models is then presented. Finally, the role that curricular reform and integration plays in the anatomical sciences within medical curricula is reviewed. A timeline of the events that are to be discussed is seen in Figure 2.1.

Figure 2.1: Timeline of Events Important to the History of Medical Education Reform in the United States



History of Medical Education in the United States

Apprenticeships

In the early colonial days of the United States, and prior to the early nineteenth century, when more formal education was developed, medical apprenticeships were one of the most common forms of medical education (Ludmerer, 1985). Even with the foundation of the College of Philadelphia (later renamed the University of Pennsylvania) in 1749 and first class enrolled in 1765 (Flexner, 1910, pg. 4), the apprenticeship system survived. Apprenticeships at that time included more informal schooling with a practicing physician (called a preceptor) and would normally last between three and four years (Robinson, 1957). The apprentice would pay their preceptor around $100 per year for the education (Rothstein, 1973). The preceptor would provide work to the student. The work would range from studying with the preceptor and learning such subjects as anatomy, chemistry, botany, physiology, pharmacy, and clinical medicine (Rothstein, 1973) to dressing patients' wounds and crafting pills. Apprentices also might have assisted with menial household chores (Robinson, 1957 and Rothstein, 1973). Once the student had mastered those basic skills, the student would be taken on house calls and would possibly be able to assist with surgeries. This was considered the clinical part of the apprentice's education. The mentor would decide when the student was ready to practice medicine on their own and then provide the student with a certificate (Robinson, 1957 and Rothstein, 1973).

The apprenticeship model for physician training had many limitations and drawbacks. For example, any physician could serve as a preceptor, so sometimes the education of apprentices was insufficient: there would be few or minimal medical textbooks, inadequate equipment, and inadequate clinical resources. There were only minimal medical licensing laws to regulate apprenticeships, so the certificate given at the end of the apprenticeship did not mean much to people who did know the preceptor (Rothstein, 1973). The only major state or colony medical licensing stipulations were that the apprentice had to be at least 21 years old after their apprenticeship had ended, and that the apprenticeship had to be around 3 years in length (Rothstein, 1973; Sigerist, 1935).

This lack of supplies, inadequate teaching of the students, and lack of strict medical licensing laws for preceptors potentially lead to the students not being adequately prepared for practicing medicine on their own (Ludmerer, 1985). However, the apprenticeship system survived because physicians found it a good way to supplement their income and obtain cheap labor, and students would receive some sort of education while not having to travel far or pay very much money (Rothstein, 1973). This system would not change until the middle 1800s, with the rise of formal medical institutions.

The Rise of Formal Medical Institutions

By the mid 1800's, the apprenticeship system was no longer the only means of medical education, due to the rising population of the country, as well as the increase in people wanting to study medicine. While the apprenticeship system was the leading avenue to becoming a physician in colonial times as well as during the late 1700s, physical medical schools were arising (Ludmerer, 1985). Many students would now travel to a medical university to study medicine (Ludmerer, 1985 and Rothstein, 1973), whether that was a medical school within the United States or a medical school abroad (Robinson, 1957).

Medical education abroad consisted of students who desired more formal medical education, so many traveled overseas to Europe (Robinson, 1957). France, in particular, was seen as the “mecca” for foreign study in medicine. In France, the hospital was the center of both medical education and research. Parisian physicians were the ones who pioneered the development of pathology in anatomy, physical diagnosis through observation, and the study of the natural history of disease (Ludmerer, 1985).

One such man who studied medicine in Europe was John Morgan. Morgan earned the title of physician by undergoing an apprenticeship in the United States, and then working for a year at the Pennsylvania Hospital. In 1760, Morgan traveled to Europe, where he studied under many different physicians in Scotland, England, France, and Italy. He received a formal medical doctorate in 1763 and worked in London for a few years. In 1765, Morgan returned to America and was appointed as a professor at the University of Pennsylvania (then known as the College of Philadelphia). While working at that university, Morgan set forth a plan to establish a medical school. He thus began the University of Pennsylvania Medical School in 1765 (Robinson, 1957).

With the advent of the first formal medical university in Pennsylvania, more medical schools were starting to open their doors. During the first half of the 1800s, the number of medical schools had increased dramatically (see Table 2.1). Some American medical colleges that were established in the 1700s and early 1800s included King’s College in New York in 1767, Harvard in 1783, Dartmouth in 1797, and Yale in 1812 (Ludmerer, 1985). King’s College was started by doctors who learned the formal trade of medicine in Europe, much like John Morgan. However, unlike Morgan, those doctors did not advocate for a comprehensive medical teaching program, save for the development of a hospital association with the college. In 1771, the New York Hospital was chartered and associated with the university, which eventually became the College of Physicians and Surgeons of Columbia University (Robinson, 1957). The medical school at Harvard College was begun by John Warrant, who was a product of the apprenticeship system and held no formal medical degree. Warren was appointed as a professor of anatomy and surgery by the president of Harvard. Benjamin Waterhouse was a colleague of Warren's who received formal medical education overseas and was made professor of physics. In 1821, the Massachusetts General Hospital was opened and associated with the university (Robinson, 1957). The medical school at Dartmouth, located in Hanover, New Hampshire, was the first one in the United States to not be located near a large city. This school was begun by Nathan Smith, who also had worked as an apprentice, but then attended Harvard Medical School in 1790 to receive more formal education. Smith traveled to Europe to work as a physician for a few years, and then came back to America with books and other medical equipment for his proposed school (Robinson, 1957). After working at Dartmouth for about a decade, Nathan Smith was appointed professor of theory practice of surgery and obstetrics at the Medical Institute of Yale College in 1812 (Robinson, 1957).

Table 2.1: American Medical Schools Granting a Medical Degree by Year, 1770-1870

Year	All American Medical Schools
1770	2
1780	2
1790	3
1800	4
1810	6
1820	13
1830	22
1840	30
1850	42
1860	47
1870	60

This table comes from Rothstein, 1973 with data extracted from Norwood, 1944.

Standard Medical Education Curricula in the 19th century

In the 19th century American medical schools, the standard course of instruction consisted of two 4-month terms of lectures. Within the curriculum's lectures, there were generally three broad fields of instruction: basic sciences, the theory and diagnosis of disease, and the treatment of disease (Shafer, 1936). The basic sciences would consist of chemistry, anatomy, and physiology. The second grouping of studies would include pathology and the theory of medicine. The third grouping (treatment of disease) would include studies in the theory and practice of physic (treatment), materia medica (drugs), surgery, and midwifery, including obstetrics and diseases of children (Rothstein, 1973). The universal system of medical education was that students would take those classes for one term, and then they would repeat them for the second term. This repetition of courses allowed for students to receive all the needed information for the courses at least once, due the small number of professors who were willing to teach the courses, as well as the scarcity of textbooks for the students, possibly resulting in the students having to share textbooks (Shafer, 1936).

Within this more formal medical education, there would be no formal laboratory experiences, except, perhaps, in a human anatomy dissection lab. The dissection course was not a requirement for graduation due to anti-dissection laws and public opposition to dissection at that time, but many universities still went through with their own dissection courses, either in secret or more openly (Rothstein, 1973). Bodies for the dissection course would sometimes be obtained in shady manners, such as digging up graves (Robinson, 1957). In 1832, the Warburton Anatomy Act was passed in the United Kingdom, which legalized the use of unclaimed bodies for anatomical study. However, there was no such similar law in the United States for many years, and grave robbing of bodies for medical study continued (Robinson, 1957), along with using the bodies of criminals and people who committed suicide (Shafer, 1936). This didn't change in the United States until 1883 with the passage of the Pennsylvania Anatomy Act which allowed teachers and medical students to dissect cadavers without having to purchase bodies from grave robbers (American Association for the Advancement of Science, 1896).

During this time, apprenticeships still existed to supplement the classroom lectures. Clinical subjects would be taught by the preceptor, whereas only the basic science subjects would be taught by the medical university faculty. The apprenticeship lasted approximately three more years, much like the colonial apprenticeships.

A final oral examination would occur at the end of the schooling, after the student had concluded with their lecture study and apprenticeship, and, if passed, the student would be granted a medical doctorate (MD) degree (Ludmerer, 1985 and Rothstein, 1973).

The makeup of the student enrollment at the American medical schools during this time was primarily white males (Robinson, 1957). Women and black Americans had much harder times getting into medical schools. Prior to the Civil War, blacks were mostly denied admittance to medical school, and it wasn't until 1869 that blacks could be wholly educated in medicine, when Howard University opened (Ludmerer, 1985, pg. 14). Women could be admitted to medical school during that time, though it was not very common. In 1849, Elizabeth Blackwell was the first woman to graduate from an American medical school (Ludmerer, 1985, pg. 14).

In contrast to the American medical education system, the European medical education system included four years of courses (usually the same subjects as the American medical students). Students were required to pass an oral examination to attain a medical degree, but students would also have to submit a thesis, as well as defend two diagnoses of patients, all before a group of committee members for the university (Shafer, 1936).

The 19th century American medical institutions were still struggling with producing adequately-trained physicians (Ludmerer, 1985). One reason for this was how the medical institutions were organized. Many early medical schools were proprietary in nature, where money generated from student fees would go towards the salaries of professors and administrators. Proprietary schools wanted to maximize their enrollment to increase their income and reputation, so professors didn't want to make their standards of enrollment and instruction too strict, for fear of losing students, and students flocked to schools which had lax standards (Ludmerer, 1985). Harvard, in particular, decided against prolonging its lecture term from four to six months for fear of losing student enrollment (Ludmerer, 1985). Faculty members across the country saw medical school as a sort of trade school, whose function it was to educate students only in the relevant medical information; any additional education (such as in social science or humanities) was seen as irrelevant and unnecessary (Ludmerer, 1985).

Another factor involved with the high medical school enrollment, but poor training of physicians, was that there were no admission requirements at most medical schools, so the prior education of incoming students was varied. A President's Annual Report completed at the University of Michigan (1872) stated that only fourteen of 350 medical students held a college degree. It wasn't until 1893 that the medical colleges even required a bachelor's degree with competencies in chemistry, physics, and biology to first be attained before being admitted to a medical program (Flexner, 1910). Another report from Harvard University (1879-1880) noted that many medical students were illiterate. Sometimes students would even purchase their own diplomas if they could not earn one (Kaufman, 1971).

At many 19th century American medical schools, lecture halls were crowded with students. Students would spend 6-8 hours a day crowded into those classrooms. There were no clinical facilities to practice with patients, and there were no lab sessions for practical application of the lecture material learned (Ludmerer, 1985). Many students had never even used a microscope before (Walker, 1891). Faculty themselves distrusted the laboratory experience, for fear of "dehumanizing aspects of science" (Ludmerer, 1985, pg. 24). The responsibilities of most faculty members would only be to lecture and complete some administrative duties. Rarely would they ever complete their own research, and this contributed to the lack of general laboratory facilities (and lab classes) at universities. Only at more prestigious institutions did students complete a human dissection course (Ludmerer, 1985), as was previously mentioned in this section.

Some of the requirements for a US medical diploma in the 19th century were described by Patrick Macaulay, a physician at that time and friend of Johns Hopkins. As Macaulay stated, "A young gentleman enters a physician's office, he reads twelve months, repairs to some medical college, and after an attendance at most on two courses of lectures, receives a diploma" (French, 1953, pg. 564). Lax attendance standards in lectures were quite common, where many schools would grant credit to students for only attending four to six weeks of classes, compared to the four months that was normally taught (Report to the Committee on Medical Education, 1871). Licensing of physicians by the state also did not exist at that time. The graduated physician was free to practice medicine anywhere in the country (Ludmerer, 1985). American medical education at this time was floundering, producing inadequately trained physicians at an alarming rate. Change needed to happen.

Early Efforts of American Medical Education Reform

Considering many of these problems in 19th century American medical schools, many approaches to reform of the medical education system developed. These reform developments varied in their success. Each effort is described below.

Reform of the apprenticeship system

John Morgan, the founder of the University of Pennsylvania Medical School in 1765, set forth a plan for medical education reform of the apprenticeship system by the creation of universities specifically for medical education. In this plan, he wanted students to engage in "observation and physical experiments;" he wanted them to "have their minds enriched with…languages and liberal arts" (prior to entering and also during medical school); and he pointed out the benefits of having a medical school associated with a hospital (Robinson, 1957, pg. 5). In short, he discussed the advantages of the European style of medical education, where each medical subject is taught by a group of specially-trained professors, as opposed to the apprenticeship system which was still prevalent in America (Robinson, 1957).

The American Medical Association (AMA)

Physicians themselves perceived the issues of the American medical education system to be a major concern affecting their profession. It was due in part to these concerns that the American Medical Association (AMA) was established in 1847 (Ludmerer, 1985).

The AMA was not solely created for medical education reform, although this reform was a major concern of the committee members. The AMA was composed of many committees, including the Committee on Medical Education (Fishbein, 1947). This committee pointed out that the standards for achieving a medical degree in most foreign countries were much higher than the American standards. The committee also noticed that there were far too many medical schools and thus doctors in the United States, primarily from the lack of entrance requirements and general ease of attaining a medical degree. In the early nineteenth century, there were only around 1,000 doctors in the United States (Shafer, 1936). In contrast, by the mid nineteenth century, there was over 15 times that number of doctors in America (Rothstein, 1973). The large number of physicians meant there was competition among practitioners, and many doctors could not support themselves solely on their medical practice (Shafer, 1936). The AMA wanted to change these aspects of medical education.

Another one of the resolutions that the members of the AMA put forth, in the mid-nineteenth century, was that the medical school term should be extended from 4 to 6 months, along with having a three-year graded curriculum, as opposed to a two-year ungraded curriculum (Rothstein, 1973). This extended time frame for medical school, according to the AMA, would include sufficient time for the teaching of the required courses that are mentioned above, inclusion of laboratory practice, inclusion of clinical practice at the affiliated hospital, and time for independent study and research (Ludmerer, 1985).

This increase in the time frame for attainment of a medical degree was important because during this time there was an immense amount of new medical information to be learned. There were new medical devices and theoretical concepts being developed, and there were advances in physics and chemistry occurring. During the mid-1800s, there were many discoveries arising such as the discovery of anesthesia in 1846, the development vaccines in 1879, and the invention of high magnification lenses for microscopes in the 1870s (Fishbein, 1947; Rothstein, 1973).

Many of these efforts at reform by the American Medical Association failed, as many medical schools ignored the AMA recommendations. The only school to adopt any increase in term was the University of Pennsylvania Medical School, which increased its term to only five months but didn’t adopt the three-year graded curriculum reform until much later (Rothstein, 1973).

The AMA was also unsuccessful in reducing the number of medical schools in the United States. These unsuccessful reforms created clashing relationships with the AMA and with medical schools. Many medical schools believed the AMA was attempting to change too much with medical education. This discordance between the society and medical schools led to the AMA expelling medical schools from participating in their society (hospitals, dispensaries, boards of health, and a few other organizations could still have representation in the AMA) (Rothstein, 1973).

The Association of American Medical Colleges (AAMC)

Another medical association that came about just after the AMA was the American Medical College Association (later renamed the Association of American Medical Colleges or AAMC) in 1876. (Ludmerer, 1985 and Rothstein, 1973). The AAMC required all participating medical schools to adopt a three-year graded curriculum with six-month terms each year, entrance requirements including attainment of a high school and college diploma, and graduation requirements including passing oral and written examinations in arithmetic, algebra, physics, and Latin, as well as composing a thesis in English using proper grammar and sentence construction. By the early 1900's, the AAMC increased the length of medical school to four years, with at least 6-month terms (Smiley, 1957). Table 2.2 lists the breakdown of the late 1800's American medical schools and their course length. Note how in 1885, almost all medical schools were 2 years in length. The length of the term for medical schools gradually increased to 3 and 4 years, by 1897. By 1899, all but a few medical schools had a 4-year term.

Table 2.2: Length of Course of Medical Schools, 1885-1899

Year of Report	Length of Term for Medical Schools				Total (%)	# of US Medical Schools Reporting
	4 years (%)	3 years (%)	2 years (%)	1 year (%)		
1885	0	5	95	0	100	108
1897	66	33	0	1	100	150
1898	71	29	0	0	98	145*
1899	91	7	1	1	100	155**

*Six schools not reporting
**One school not reporting
This table comes from Rothstein, 1973, with data extracted from Taylor, 1900

However, despite these calls for curricular revision, many medical schools still did not change their curricula, to the utter dissatisfaction of the members of the AMA and AAMC. It was understandable that medical schools did not follow this advice, however. Many professions were against national regulation of their occupation, and many in the medical profession were not convinced that any one brand of medical education was the best (Beck, 2004).

The AMA still tried to enact change in the medical education system by administering a survey of medical school teaching practices in 1906 and 1907. What they found was that many medical schools had very unsatisfactory teaching practices, including lack of coordination of teaching topics among faculty, but they did not want to anger the existing members of their organization, so this information was never published (Ludmerer, 1985). An impartial third party was brought in to conduct their own survey in 1908, instead of publishing the AMA findings. The American Medical Association asked the newly established Carnegie Foundation for the Advancement of Teaching, founded by Andrew Carnegie, to survey medical schools on their teaching practices. This survey was administered by Abraham Flexner (Irby et al., 2010), and from this survey came the Flexner Report (Flexner, 1910), described in detail next.

The Flexner Report

Overview of the Report

Medical Education in the United States and Canada: A Report to the Carnegie Foundation for the Advancement of Teaching (Flexner, 1910), more commonly referred to as the "Flexner Report," was written by Abraham Flexner in 1910. Flexner first began his career as a high school teacher and then as a professor at the college level. Before he wrote the Report, he had served 20 years as an educator, while also being proficient at psychology, which he studied in Europe. Henry Pritchett, the president of the Carnegie Foundation, hired Flexner to go to each of the 155 allopathic medical schools and conduct a survey to evaluate the design of their educational programs (Zelenska, 2008). The evaluation process included looking at the laboratory setup, entrance requirements, how much training the educators had, the tuition and endowment of the medical school, and availability of a teaching hospital for clinical practice (Beck, 2004).

The Report was divided up into two different sections. The first section discussed the history of medical education along with how medical schools should go about educating their students (termed the *proper basis*) and also how medical schools actually go about educating their students (termed the *actual basis*) (Flexner, 1910). In the second part of the Report, Flexner summarized findings from each school he visited (Hiatt & Stockton, 2003). Flexner also recommended many changes to the curriculum at medical schools. Most inauspiciously, Flexner noted, "The schools were essentially private ventures, money-making in spirit and object" (Flexner, 1910, pg. 7). These medical schools were proprietary schools, created to generate a profit for the professors and administrators.

Flexner proposed some recommendations for the medical schools that did not live up to the standards set forth by the AMA, AAMC, and the Carnegie Foundation (Ludmerer, 1985). Some of the recommendations included reducing the number of schools from 155 to 31, by closing medical schools that met the following criteria: those that had 100 or fewer students enrolled, proprietary schools, and those schools not affiliated with a hospital (Flexner, 1910, pg. 154). Flexner also proposed merging medical schools that were in close proximity to each other. He also proposed increasing the prerequisites needed to enter all medical schools (pp. 25-26), training physicians using the scientific method (pg. 25), and strengthening state regulation of medical licensure (pp. 167-173). While the number of schools would be reduced (and thus number of students entering school and physicians graduating from schools), the remaining number of students would be better trained and educated physicians (Zelenska, 2008).

Johns Hopkins Medical School, opened in 1893, served as the model that Flexner believed all other medical schools should follow. During the latter part of the nineteenth century, some American medical schools were slowly inching towards curricular revision, prodded by the AMA, AAMC, or by their own university administration, but most still did not fully adopt the reforms encouraged by those organizations. Some of the items that set Johns Hopkins Medical School apart from the other American medical schools included well-equipped laboratories, where every student had access to a microscope, full-time faculty for the basic science courses, and its own teaching hospital.

It was also the first American medical school to require a bachelor's degree as an admission requirement (Rothstein, 1973). This school was one of the first to separate the curriculum into basic science (within the first two years) and clinical science (within the last two years): this is what is commonly now referred to as the "2+2" curriculum (Cooke et al., 2010). John Hopkins was also one of the first US medical school to extend its curriculum to a full four years, two years longer than most medical schools during that time (Rothstein, 1973). Table 2.3 outlines the proposed courses of study in Flexner's Report (Flexner, 1910).

Table 2.3: Courses of Study in the Medical Education Program Proposed by Flexner (1910)

Year of medical school	**Proposed Courses in the medical education program**
1st year	Anatomy, physiology, chemistry
2nd year	Physiology, bacteriology, pathology, pharmacology, physical diagnosis
3rd year	Obstetrics, medicine, surgery, clinical microscopy, pathology
4th year	Medicine and surgery, including clerkships, specialties, etc.

Flexner wanted all other US medical schools to follow the model set forth by Johns Hopkins. He stated that physicians must be scientists and researchers who use the scientific method as a basis for their practice of medicine. This was Flexner's most fervent recommendation in his Report, what he referred to as his "scientific" school, of which he considered Johns Hopkins to be the prime example. In this idealized version of Flexner's scientific school, there would be a mutual understanding between the basic scientist and clinician (Chapman, 1974 and Zelenska, 2008).

Impact of the Flexner Report on Medical Education

The Flexner Report was seen as very credible, as it was administered by a man hired by the Carnegie Foundation, and the report was supported by the AMA. The AAMC didn't show outright support for this Report, but Flexner did believe in the 4-year curricular model proposed by that organization (Barr, 2011).

Many people believed that Flexner's tone in his report was irritating, but many people also conceded that some sort of change was necessary (Zelenska, 2008). In 1910, Flexner persuaded John D. Rockefeller, a friend of Andrew Carnegie and a very wealthy man, to set aside $50 million in order to implement many of the recommendations of the Report, such as establishing full-time teaching positions in the medical schools as well as improving clinical teaching facilities by allocating money for laboratory equipment (Chapman, 1974 and Zelenska, 2008).

One of the main impacts of the Report was the reduction in number of American medical schools. Proprietary medical schools were starting to shut their doors only a few years after the Report (Beck, 2004). By 1928, the number of medical schools had dropped to only 76 from 155 (Chapman, 1974). It is not actually known why these medical schools closed. Perhaps it was due to the fact that they didn't want to handle the development of the "2+2" curriculum or the creation of more stringent entrance requirements. It was never explicitly stated in the sources that were researched.

While some schools were shut down, others were restructured. Columbia University is an example of one of the schools whose resources were combined with Presbyterian Hospital to form a new medical center, with an endowment from the Carnegie Foundation, the General Election Board, and the Rockefeller Foundation. Those three organizations also gave money to similar medical institutions that would reorganize themselves in much the way that Columbia did, following the recommendations of the Flexner Report (Zelenska, 2008).

Within one decade of the Report, most of the remaining medical schools adopted the “2+2” curriculum (Chapman, 1974). The vision of Flexner’s “scientific” school did come fully to fruition a few decades later. This included many medical schools having an emphasis on strong basic science departments, a focus on research, full-time faculty, and effective involvement with the school’s parent university, which was not a common occurrence prior to that time, despite medical universities having the same name as their parent universities (Chapman, 1974). This involvement with parent universities was a way to “expedite the exchange of knowledge and information between laboratories of sciences and clinics of treatment and care” (Zelenska, 2008, pg. 88).

By 1924, almost all medical schools had created entrance standards including graduating from high school and having a minimum of two years in college, including taking courses in biology, chemistry, and physics (Zelenska, 2008). By the 1950’s, it was required by the medical school admissions boards as well as the AMA and AAMC for students who desired to enter medical school to first earn a bachelor’s degree (Chapman, 1974).

Not all of these recommended changes in the Flexner Report produced positive results. For example, Flexner’s ideology of having educators be both clinicians and scientific investigators was becoming compromised. In the latter half of the 1900s, it was becoming quite difficult to be a skilled clinician, proficient scientific investigator, and educator. Medical advances were increasing rapidly, and more time was spent away from the classroom and clinical practice and in the laboratory. The call for every medical school to be a "scientific" school was being deemphasized (Chapman, 1974).

There also was a problem due the dissolution of many medical schools: by the 1960s and 70s, there were not *enough* doctors in the US, due to the growing population and rapid increase in demand for physicians (Chapman, 1974). In 1970, the Carnegie Commission issued a report entitled *Higher education and the Nation's health; policies for medical and dental education. A special report and recommendations* (Kerr, 1970) which recommended an increase of up to 75% more medical students by the end of that decade. The report stated that the increase in students could be accomplished by shortening the length of time it takes to become a practicing physician from 8 years (4 for their medical degree and typically 4 for their internship/residency years) to only 6 years (3 medical and 3 internship/residency), by increasing the size of existing medical classes to 100 or even 200 students, and by increasing the number of new medical schools (Chapman, 1974). There was also a higher demand for more family physicians as opposed to highly trained specialists in other areas of medicine (Chapman, 1974).

In some regards, the Flexner Report created more problems, by encouraging the closure of too many medical schools and having idealized a little too much change in those schools. However, it did set an important precedent for medical education curricular reform. Flexner himself was never a faculty member at a medical university, so he did not completely understand the intricate workings of the medical university system, especially the resistance to any major change (Chapman, 1974). However, from his Report, many other reports about medical education from other medical societies came about. These reports are discussed in the next section.

Curricular Reform after Flexner –Mid to Late 20th Century

In the mid to late 20th century, physicians and educators recognized that medical education had not undergone significant revision since the Flexner Report. Several organizations reviewed the state of medical education and developed reports for curricular reform recommendations.

One such report written after the Flexner Report was the *Physician for the Twenty-First Century: The Report of the Panel on the General Professional Education of the Physician and College Preparation for Medicine* (Association of American Medical Colleges, 1984), also referred to as the GPEP report, released by the AAMC in 1981. This report, with viewpoints and recommendations from 83 medical schools, was divided into a few different sections. One section identified the need to assess the current approaches to premedical (undergraduate) education. In it, the report stated that premedical education should be a rigorous but broad overview of many subjects in the natural and social sciences and the humanities. The report also described how the MCAT (Medical College Admission Test) should include an essay portion to assess the students thinking and writing skills, rather than focusing entirely on the biology, chemistry, and physics portions of the exam. The MCAT was first known as the Moss Test or Scholastic Aptitude Test for Medical Students (SATMS) and was developed in 1928. It was the beginning of standardized testing as part of admission to medical school. In 1948, the test had its named changed to the MCAT (McGaghie, 2002).

Another section of the GPEP report identified the need to assess medical education practices. That section called for the reduction in lecture hours. During the early 1980s, around 79% of US and Canadian medical schools had between 800 and

1,000 lecture hours scheduled for the first two years of medical school (pg. 25). This report called for the reduction in lecture hours (no specific number was given) or at least replacement with lab sessions or tutorial groups. That section also called for medical faculty to promote independent learning and problem solving by forming hypotheses, critically evaluating data, and merging new knowledge with the analysis and solution of problems. These skills were seen as an important part of the student becoming a physician, with problem solving being an important part of the occupation. Another section called for improved integration between the biological sciences and clinical training components of medical education, a major component that will be discussed heavily in this dissertation.

Another report written in the last decade of the 20^{th} century was entitled *Educating Medical Students: Assessing Change in Medical Education – The Road to Implementation,* or the ACME-TRI report (Swanson et al., 1993). This report, which was also sponsored by the AAMC, identified barriers to medical education in the last few decades, documented results of a survey sent out to the 143 (at that time) US and Canadian medical schools, and proposed recommendations such as promoting self-directed learning and lifelong learning skills, formally assessing clinical skills, and reducing the number of lecture hours.

A more recent report entitled *Educating Physicians: A Call for Reform of Medical School and Residency,* which was sponsored by the Carnegie Foundation for the Advancement of Teaching (Cooke et al., 2010), followed in the footsteps of Flexner by visiting medical universities around the country and reporting on their curricula. Though it was found that many medical schools were already changing their curricula to be more integrated and allowing for more active learning, the authors still found that medical training was excessively long and not learner-centered, and that students were not learning connections between formal knowledge and experiential learning. From this report, recommendations were made which included: (1) standardize learning outcomes, while individualizing learning processes; (2) promote multiple forms of curricular integration; (3) prepare physicians who are committed to excellence by cultivating habits of inquiry, innovation, and improvement; and (4) address professional identity formation (Cooke et al., 2010, pp. 5-6).

In addition to these reports, other changes were occurring that impacted medical education. One of these changes was the development of the Liaison Committee on Medical Education (LCME).

Probably considered the primary professional organization for medical education, the LCME was established in 1942 at a meeting of leaders of the AMA and AAMC to combine the resources of those two organizations. The LCME was founded because as the US entered World War II, new medical topics (such as tropical medicine) were being introduced into the curricula, and a general overseeing body wanted to ensure quality of education. This joint committee met twice a year and convened with other members of the AAMC and AMA to discuss problems at medical schools and their recommendations (Kassebaum, 1992).

The LCME currently serves as the accrediting agency for medical schools in the US and Canada that grant an MD degree. In order for US and Canadian medical schools to receive their accreditation, standards were created by the LCME by which schools are evaluated. The LCME bases those standards on medical schools whose "graduates exhibit general professional competencies that are appropriate for entry to the next stage of their training and that serve as the foundation for lifelong learning and proficient medical care" (LCME, 2018, pg. iv). There are 12 standards which medical schools must adhere to in order to receive accreditation (LCME, 2018):

1) Mission, Planning, Organization, and Integrity. The medical school should have a written statement of its mission and goals, which also outlines an organizational structure and governance process (pg. 1).
2) Leadership and Administration. The medical school should have a certain number of faculty in leadership and other senior roles with the skill necessary to achieve the goals of the medical school (pg. 3).
3) Academic and Learning Environments. The medical school should have its classes occur in an enriching academic and clinical environments (pg. 4).
4) Faculty Preparation, Productivity, Participation, and Policies. The medical school faculty should provide leadership and support which are aligned with the university's educational, research and service goals (pg. 5).
5) Educational Resources and Infrastructure. The medical school should have sufficient resources and faculty across all schools in order to meet its goals (pg. 6).
6) Competencies, Curricular Objectives, and Curricular Design. The medical faculty should design competencies for their students to attain, and the faculty should design and implement the curriculum in a fashion that will help the students achieve those competencies – this includes having clinical experience, self-directed learning, and service learning (pg. 8).
7) Curricular Content. This includes having biomedical, behavioral, and social sciences in the medical curriculum, as well as having experience with the scientific method and clinical and translation research (pg. 10).
8) Curricular Management, Evaluation, and Enhancement. Medical school faculty should engage in curricular revision and program evaluation to ensure that students are receiving the best quality education (pg. 12).
9) Teaching, Supervision, Assessment, and Student and Patient Safety. Medical schools should provide both formative and summative assessment of student knowledge. Students should also be safely protected by ensuring that all faculty and other personnel are adequately trained and prepared for their responsibilities (pg. 14).
10) Medical Student Selection, Assignment, and Progress. The medical school should establish and publish its admission requirements and use

effective procedures by which to select students for admission (pg. 16).

11) Medical Student Academic Support, Career Advising, and Educational Records. All medical students have the same rights and should receive comparable services (pg. 18).
12) Medical Student Health Services, Personal Counseling, and Financial Aid Services. All medical students have the same rights and should receive comparable services (pg. 20).

A medical school typically has its accreditation status reviewed and renewed every eight years, only if the previous review was positive. If the review was negative or if the school was put on a probationary status, review would next occur in three years. Accreditation of a medical school involves the LCME reviewing the above standards with the school, the school carrying out a reflective self-study, members of the LCME conducting a site visit to verify findings, and finally another group of people from the LCME determining the accreditation status and making any recommendations to which the medical school should adhere (LCME, 2018). Many medical schools have revised their curricula in order to more closely align with the recommendation of Cooke et al. (2010) and the standards set forth by the LCME (Fishleder et al., 2007; Heiman et al., 2018; Kitzes et al., 2007; and Skochelak, 2010).

But the first question that comes to mind even before the revision of curricula: what *is* curriculum? Curriculum was touched on briefly in the History of Medical Education sections, describing how the medical educational content and delivery has changed in the last few centuries, but the word curriculum has not yet been defined here. Curriculum is a complex word which can have many definitions and interpretations that will be discussed in the next section.

Definition of Curriculum in Education

What do schools teach, how do they teach it, and who teaches it? These are all basic questions that aim to be answered by the development of an educational program. While these can be simple questions that can and should be answered by a school's curriculum, the very nature of curriculum is more complex and does not lend itself to a universal definition.

Curriculum may be defined as "all the learning which is planned and guided by the school, whether it is carried on in groups or individually, inside or outside the school" (Kerr, 1967, pg.6). Specific medical curricula will be discussed Chapter 4 of this report.

The Medical Curriculum

Overview of Medical Curricula

American medical curricula have changed greatly in the last 250 years. Medical curricula began very informally with the apprenticeship model, where the student would study with their physician-preceptor for around 3 years, learning the subjects that the physician was willing and able to teach, and then be granted a certificate at the end to practice medicine. It then progressed to education in physical institutions, yet many of those medical colleges had no admission requirements and were only there to generate a profit by enrolling as many students as they could. Before the Flexner Report of 1910 was released, many American medical schools would only utilize lectures to educate students, and students only had to attend 2 years of classes. Johns Hopkins Medical School was one of only a few medical schools in the United States during the late 1800s/early 1900s that had adopted a 4-year medical curriculum, 2 years of basic sciences and 2 years of clinical work ("2+2" curriculum), which is now the common curriculum of medical schools (Cooke et al., 2010).

In general, the types of courses taught in medical school should build on the fundamentals learned in college undergraduate courses, such as subjects in biology, chemistry, and physics, which are all prerequisites for medical school (Cooke et al., 2010). The first two years of medical school expand upon those basic science subjects by looking at the structure and development of the human body at the cellular, tissue and organ level as well as learning about the mechanisms of disease and treatment. In a traditional Flexner medical curriculum model, there usually are six subjects taught in the first two years of medical school: anatomy (including neuroanatomy and embryology), histology (microscopic anatomy), physiology, microbiology, biochemistry, pharmacology and pathophysiology. The third year of schooling is part of the clinical practicum where students rotate through clerkships in family medicine, internal medicine, neurology, obstetrics and gynecology, pediatrics, psychiatry and surgery. In the fourth year, students complete rotations in different electives (Cooke et al., 2010). Some schools may have specific focuses in their education and clerkships offered such as rural medicine and urban medicine (a focus in emergency medicine) in rural and urban locations, respectively. Other medical schools may address public health issues, and some will have more focus in research and academics. Unique medical curricula from different schools may be seen in Appendix A.

The four years of medical school are classified as undergraduate medical education (UME), which should "equip physicians in training with the foundational knowledge, skills, and professional values to relentlessly pursue excellence in the practice of medicine within their chosen specialty" (Cooke et al., 2010, pg. 75). By the time the students graduate from medical school, they enter graduate medical education (GME), which consists of their internship and residency, and the time and skills required will vary depending on their specialty (Cooke et al., 2010).

More recently, there has been an increase in the number of medical schools that have created accelerated three-year tracks for their medical students. These accelerated tracks are primarily created for students interested in primary care specialties, and they help to cut down on student debt accrued throughout medical school. Only nine allopathic medical schools as of 2017 have an accelerated track (Schwartz et al., 2018), and it remains to be seen if more medical schools follow this trend in the future.

While the traditional (aka Flexner model) of American medical schools may follow the "2+2" curriculum, there are many other medical curricula that schools follow. An overview of common medical curricular models is found below.

20th Century Medical Curricular Models

Formal medical education in the nineteenth century consisted of no set curriculum that medical schools would follow. It was usually up to the discretion of the schools on how to teach their courses. Usually there would be only two years of coursework and minimal clinical training. It wasn't until the early twentieth century when the Flexner Report was published that more standardized medical curricular models developed. Most medical schools eventually adopted the "2+2" curricular model of 2 years of basic sciences and 2 years of separate clinical work. Some schools even currently retain that model at their institution. However, by the 1950s, medical schools were starting to change the type of curricular model that they followed.

There have been five different types of medical school curricular models proposed by Papa and Harasym (1999), which include the apprenticeship model (previously discussed in the first part of this chapter), the discipline-based model, the organ systems-based model, the problem-based learning (PBL) model, and the clinical presentation (CP) model. Each model (except the aforementioned apprenticeship model) is referenced in Table 2.4, with a more in-depth description on the following pages. It should be noted that there can be great variance in these models. One school may have a discipline-based approach the first year of medical school, while the second year has an organ-systems approach. Or the school can have a mix of discipline and organ-systems approach. There is no “one size fits all” approach to medical education.

Table 2.4: Proposed Medical Curricular Models by Papa and Harasym (1999)

Curricular model	**Definition/explanation**	**Selected examples of curriculum in the literature**	**How are the anatomies (gross, micro-, and neuro) taught in this model?**	**Positives**	**Negatives**
Discipline-based	• Began in 1871 at Harvard Medical School • Focus was on 4 year curriculum with 2 years basic sciences and 2 years clinical work • Modeled after the system found at many European medical schools • Classes taught separately by their discipline • Faculty split into discipline-specific departments	Cooke et al., 2010; Custers, 2010; Flexner, 1910; Harden et al., 1984; Hecker and Violato, 2008; Papa and Harasym, 1999; Schmidt et al., 1996;	Taught as separate classes	• Teachers may be more excited to teach in their own discipline • Low cost	• Lack of patient interaction • Little thought given to sequence of classes • Passive learning • Lack of problem solving and diagnostic abilities • Surface learning
Systems- based	• Began in 1951 at Case Western Medical School • Disciplines taught in respective organ system units (e.g., cardiovascular, GI)	Brooks et al., 2015; Cooke et al., 2010;Hecker and Violato, 2008; Hecker and Violato, 2009; Hopkins et al., 2015; Muller, 2008; Papa and Harasym, 1999; Schmidt, 1996;	Integrated with clinical and basic sciences within organ-systems modules	• Use clinical information for clerkship years • Cross disciplinary interconnections (integration)	• Opposition of faculty for team teaching • Decreased time to teach all of material • Balance of basic science educators

	• Incorporation of clinical material in preclinical years • Interdisciplinary collaboration/team teaching			• Possible hands-on learning with patients	and clinical instructors • Higher cost
Problem- based	• Began in 1969 at McMaster School of Medicine • Small group discussions of 5-8 students and 1 faculty preceptor per group • Clinical scenario presented to group • Collaboration to discover correct diagnosis and treatment while using basic science information • PBL modules are different • To qualify as this curriculum, majority of time should be PBL modules and should be stated in curriculum directory	Barrows and Tamblyn, 1980; Des Marchais, 1992; Donner and Bickley, 1993; Gurpinar et al., 2005; Hartline et al., 2010; Hecker and Violto, 2008; Hmelo, 1998; Koh et al., 2008; Nandi et al., 2000; Newble, 1986; Papa and Harasym, 1999; Schmidt et al., 1996	They are woven in with the clinical sciences in the problem based learning sessions	• Promotion of good student-faculty relationships • Promotion of teamwork and communication skills among students • Perform well on clinical exams • Perform well on diagnostic skills • Understand material better when students reach their clerkship years and beyond	• High cost • Uncomfortable in small group settings • Lack of time for faculty to teach in their own discipline • Increased faculty workload • Harder to do with large classes

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Clinical Presentation	• Began in 1991 at University of Calgary Faculty of Medicine • Based around identification of ways that patients present to clinicians to figure out diagnoses • E.g., chest pain, headache, dyspnea • Utilizes problem solving skills	Hecker and Violato, 2008; Hecker and Violato, 2009; Mandin and Dauphinee, 2000; Mandin et al., 1995; Papa and Harasym, 1999; West et al., 1991; Woloschuk et al., 2004	They are organized around clinical presentations and clinical presentation schemes	• Don't have to restructure knowledge and thinking during clerkship phase • Chunking of information for schemas, which can reduce memory load	• High cost • High faculty workload • Have to reorganize way of thinking during preclerkship phase

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This dissertation research will show that there are many different ways in which medical schools can classify their curricula. Papa and Harasym's medical curricula classification schema is almost 20 years old, and since that time, much has changed in the realm of medical education. There is a need for a current review of curricular models at institutions across the United States.

<u>Discipline-based curriculum (aka 'traditional' medical curriculum)</u>

From as early as the mid to late-1800s, to the release of the Flexner Report in 1910 and up until the 1960s, the type of curriculum of most medical schools was called discipline-based curriculum (also now referred to as traditional curriculum). In this type of curriculum, the basic science subjects are taught in the first two years and clerkships (clinical sciences) occur in the last two. However, clinical information is not incorporated with the basic science information. In many cases, clinical information is not taught until the students undergo their clerkship rotations in their last two years, when they interacted with patients (Cooke et al., 2010).

This type of curriculum has a low cost in terms of work load and time spent on the curriculum. Most medical schools have had this curriculum at some point, so there is no need to significantly revise it. Faculty may also find that they prefer to teach in their own discipline, as opposed to having to engage with faculty members of other disciplines (Harden et al., 1984).

The challenge with this type of curriculum is that students may not retain the information they learn very well if they cannot use it in a real-life scenario. Students may only learn the information in a passive manner, by listening to their professors' lectures, and this can lead to only having a surface approach to learning, which is only learning or memorizing basic information and not connecting it to a deeper meaning (Marton and Säljö, 1976; Schmidt, 1996). A review of the literature on long term retention of basic science knowledge showed that students can lose up to 50% of the knowledge taught in the basic science years when they reach their clerkships if they have not learned the information in a meaningful way, such as combining basic science knowledge and clinical scenarios (Custers, 2010).

<u>Organ-systems based curriculum (systems-based curriculum)</u>

Another type of curricular model is called an organ systems-based curriculum or just a systems-based curriculum**.** In this type of curriculum, there is usually integration of basic science information and clinical information in organ systems-based units. The first medical school to implement this was Case Western Reserve University Medical School in the 1950s (Papa and Harasym, 1999). Lectures on a topic are combined using a single organ system as the focal point, such as the musculoskeletal or cardiovascular system. Students ideally then learn all the anatomy, physiology, histology, etc. for that organ system. Faculty from the different departments in a medical school are required to work together (called interdisciplinary collaboration or team teaching) to coordinate their lectures for the different organ system units (Cooke et al., 2010).

Information that is learned in the first two years of an organ-systems program can be easily transferred over to clerkship years, since the student has spent time with patients and clinical scenarios (Cooke et al., 2010; Papa and Harasym, 1999; Schmidt, 1996).

An issue that may occur with the organ systems curriculum is that students may just be thinking of their patient as organs, and not as a whole person (Papa and Harasym, 1999). Other issues that might also arise include not having classes organized well.

Muller et al. (2008) found that students involved with an organ systems-based curriculum still had lectures that were more discipline-specific, and that material in the systems units were not integrated in a meaningful manner. Along those lines, since material has to be shifted from classes taught by disciplines, to classes organized around organs, information for each discipline may be reduced to some extent. There must be careful consideration on how much information is sacrificed for clinical content (Brooks et al., 2015).

An example of an organ systems-based curriculum is at Indiana University School of Medicine (IUSM) in year 2 of the program. In the "Cardiovascular and Hematology" block course (6 weeks long), the students are prompted to use their knowledge of the physiology, pathophysiology, and pharmacology of those two systems to describe the major diseases of those systems, with their signs and symptoms, and learn skills in the clinical lab setting to know how to diagnose and treat patients with those diseases (IUSM, 2018).

Problem-based curriculum

Another type of curricular model that developed in the latter half of the 1900s is the problem-based curriculum enacted by Dr. Howard Barrows and McMaster University in the 1970s (Barrows and Tamblyn, 1980). This model encompasses the use of problem-based learning (PBL) modules. Students are divided into groups of 5-8 per group and given a scenario of a patient. This scenario might include the signs and symptoms of a patient, and it will eventually include tests that are run on the patient and their results. It is the goal of the groups to work out the final diagnosis and treatment of the patient (Papa and Harasym, 1999).

Many medical schools in the United States utilize some aspects of this curriculum, but only a few have a full problem-based curriculum. Hecker and Violato (2008) state that in order to qualify as having a full problem-based curriculum, each course in the curriculum must use PBL modules, and it must state this in the curriculum directory. Students may have regular lectures to learn some of the basic science information needed for the PBL sessions, but the number of PBL sessions far outweigh the number of didactic lectures.

An example of how a problem-based learning session might proceed includes having a faculty member be the facilitator of the session. The faculty member presents students with a clinical scenario. The following scenario is one that was used in a problem-based learning session at Indiana University School of Medicine-Bloomington (IUSM-B) in the "Neuroscience and Behavior" course taken by first-year medical students in the legacy (pre-fall 2016) curriculum. Note that IUSM, like most medical schools in the United States, does not have a problem-based curriculum, but may utilize problem-based learning (PBL) sessions in their own curriculum.

> Nadine is a 63yo female with hypothyroidism who presents at the Emergency Department after an episode of confusion where she became disoriented while driving around her town. The police found her at a local shopping center after her husband reported her missing.
> Her chief complaint is memory problems. She is retired early last year because she had her 30 years in. She did not have any problems at her job because of memory. She manages her own finances. However, she feels like she has to write things down more and relies on GPS more that she did in the past.
> Nadine's medical history is unremarkable and she takes no medications regularly. She has no surgical or hospitalization history and is only allergic to bee stings. She continues to stay active with golf and in social activities with peer groups.
> Nadine lives with her husband and is a retired manager with a college education. She has two grown sons who are in good health and has no significant family medical history. She does not drink, smoke, and has no

> recreational drug history. Her husband reports that her confusion has been getting worse over the past two to three years but that she seems to be stable most of the time.
> Over the past year, she admits to having a harder time remembering some new acquaintances names and this bothers her. A review of systems for Nadine reveals a mild increase in confusion episodes over the past two years with occasional difficulty remembering recent events, especially in the evening. She reports increased difficulty staying asleep and only sleeps five hours a night with frequent interruptions. She reports some anhedonia but denies any depressive symptoms, mania, suicidal or homicidal ideations. She denies any recent trauma or focal neurological deficits. She reports some difficulty initiating urination but denies any burning, urgency, or frequency. She has only had one sexual partner and has no history of sexually transmitted diseases.

Students are given a list of guidelines to help them diagnose this patient, such as, "What is our preliminary differential diagnosis?" Students then need to determine which tests to run on the patient, such as Complete Blood Count (CBC), X-rays, neurological testing, etc. Students are then given the results of those tests, and they, with their small groups, determine the final diagnosis and treatment plan of the patient. After the final diagnosis has been revealed, students are given a list of objectives that they should know about all the material they just went through, such as "become familiar with common causes and treatments for delirium in the elderly." Many times in normal lectures, learning objectives are given before that day's material, but in a PBL session, oftentimes, learning objectives are given at the end, so as not to ruin the result of the final diagnosis of the patient.

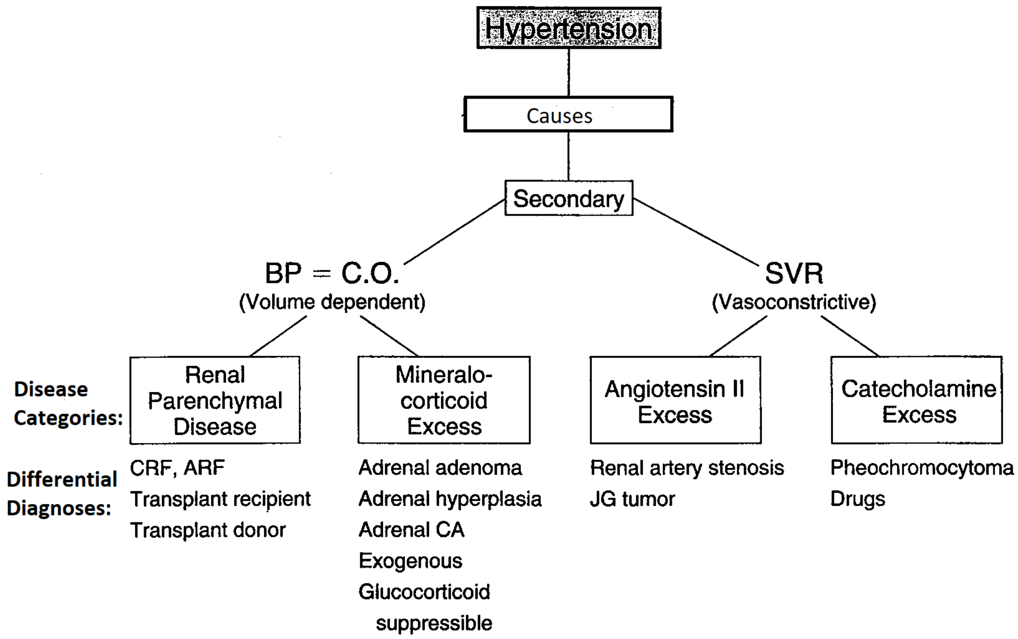
One advantage of this curricular model is that, while working in small groups, students are learning communication and interprofessional skills (Nandi et al., 2000). Students in a problem-based curriculum are able to practice these skills very often to solidify clinical reasoning skills before they enter their residency (Koh et al., 2008; Ransom et al., 2017). This type of curricular model also can lead to an increase in scores on clinical exams (Gurpinar et al., 2005) and an increase in diagnostic ability later in students' careers due to exposure to a wide variety of clinical cases (Hartling et al., 2010; Hmelo, 1998).

Some disadvantages to a problem-based curriculum is that it works better with smaller class sizes (Papa and Harasym, 1999). For instance, at IUSM-B there are only 36 students, and they only do PBL sessions at most once a week. That would be a much harder task to do with a class of over 100 students for an entire year. Another disadvantage is the time and effort it takes to create case sessions (Donner and Bickley, 1993); this can lead to teachers becoming disillusioned with high cost of time of case study generation, especially with the reduced time it allows them to teach in their own discipline (Des Marchais et al., 1992)

Clinical Presentation (CP) Model

The final type of curricular model that Papa and Harasym (1999) proposed is the Clinical-Presentation (CP) curricular model which was developed at the University of Calgary in 1991. This curricular model is based on the way that patients present to their physicians. The CP model begins with a review of the schema for the presentation (see Figure 2.2) and then progresses to a series of lectures over the basic and clinical sciences involved with the presentation, and it ends with small group problem based learning sessions to solve a case (figuring out correct disease diagnosis and any other differential diagnoses) using what they have learned. As of 2000, there have been 125±5 clinical presentations identified (Mandin and Dauphinee, 2000) and 720 disease categories identified (Papa and Harasym, 1999).

Figure 2.2: Example Schema from Clinical Presentation Model



Adapted from Papa and Harasym (1999)
This model shows an example of a clinical presentation curriculum, where a patient's sign or symptom is presented and the students work from that to discuss causes of that symptom, leading to differential diagnoses.

The CP curricular model was seen as an improvement of the problem-based model because basic science information that was being utilized in the case study within the CP curriculum was introduced *before* the case – so the students had a good part of their knowledge domain needed for that particular case study (Mandin et al., 1995). In this type of model, students can chunk their information in the different schema, which can then reduce their memory load for new information (Woloschuk et al., 2004). Chunking information encompasses different organizing strategies such as rational ordering, classifying, or arranging complex information (West et al., 1991).

However, this type of curriculum may not be entirely seen as its own separate curriculum. According to a study conducted by Hecker and Violato in 2009, which looked at the competencies of students who were enrolled in schools with different curricula, the AAMC had not classified the CP model as its own separate type of curriculum. It may be lumped in with one of the other ones proposed (discipline-based, organ systems-based, problem-based, discipline first year and organ systems second year, etc.) (Hecker and Violato, 2009).

Most of these medical curricular models have evolved from the discipline-based curricular model proposed by Flexner (1910). Even if a medical school follows the discipline-based model, there still might be some integration of basic and clinical sciences in the pre-clerkship years, which is not what the Flexner Report had recommended, but which shows a changing shift in how we educate medical students. Three reasons are often cited for this transition: (1) the overwhelming volume of information regarding human biology and medicine cannot feasibly be taught in two years, (2) this is how a clinician must think when treating a patient, and (3) evolving Liaison Committee on Medical Education standards (LCME, 2018), which require central administration of the curriculum as opposed to departmental control of individual courses.

Integrated Medical Curricula

Not only can a medical school have a combination of curricular models for their own curriculum, but many schools may also refer to their curriculum as an "integrated" one. An **integrated curriculum** has been very loosely defined in the literature. One must first start with the term "integrate," which is defined by Meriam-Webster Online as "to form, coordinate, or blend into a functioning or unified whole" (integrate, 2017).

Different researchers have different definitions for an "integrated curriculum." Brunger and Duke (2012) define it as the integration of discrete topics into a course of study. Klement et al. (2011) define it as the integration of initially separate courses or clinical experiences into a single course or unit. Yu et al. (2009) define it as the integration of basic and clinical science information. The author uses the following definition of integration from Harden et al. (1984) in this research: "the organization of teaching matter to interrelate or unify subjects frequently taught in separate academic courses or departments" (pg. 288).

These differing definitions for an integrated curriculum make it difficult for accurate comparisons among medical schools with an "integrated curriculum," including the impact that the curriculum has on the medical school and the students. This concept will be further discussed later in this chapter.

A medical school may also refer to their curriculum as having a certain form of integration, such as vertical, horizontal, or spiral curriculum (definitions adapted from Brauer and Ferguson, 2015).

- **Horizontal integration** is integration across disciplines but only for a certain period of time. An example of this is combining the basic science courses together into one block during the first year of medical school.
- **Vertical integration** is integration across time, such as integrating anatomy into clerkships and electives within years 3 and 4 of medical school, rather than just having it in year 1.
- **Spiral integration** is a combination of horizontal and vertical integration. Here, basic and clinical sciences interact at all phases of medical school; they build upon each other.

There has only been one article published that has attempted to define what an integrated curriculum is. Brauer and Ferguson (2015) proposed their own definition for an **integrated curriculum**: "a fully synchronous, trans-disciplinary delivery of information between the foundational sciences and the applied sciences throughout all years of a medical school curriculum" (pg. 318). While this is a starting point, it does not seem that this definition has caught on to be the ultimate definition that all medical educators are using right now.

With the discussion about the different types of curriculum that medical schools have, it is now necessary to know what have been the impacts of those curricular models. The next section will discuss specifically how the anatomical sciences have changed due to curricular reform at medical schools.

Medical Education Reform and the Anatomical Sciences

There are many reasons that a medical school would choose to revise its curriculum. As previously discussed, there could be pressure from medical societies to amend a curriculum, including adding integrative components to it. More specifically, the LCME, which is sponsored by both the AMA and the AAMC, sets forth accreditation standards every school year that must be met by the school, through a re-accreditation process that occurs at each school every eight years, or else the school risks being on probation. See the subsection *Curricular Reform after Flexner* for an overview of the LCME standards.

One of the LCME accreditation standards is Standard number 7: Curricular Content (LCME, 2018). This standard states, "The faculty of a medical school ensure that the medical curriculum provides content of sufficient breadth and depth to prepare medical students for entry into any residency program and for the subsequent contemporary practice of medicine" (pg. 10). More specifically, it states that the curriculum should have basic and clinical sciences incorporated into and taught through each organ system and through each phase of the human life cycle. While the standard does not explicitly say "integration of basic and clinical sciences," many medical schools probably assume that should be part of their curriculum.

There was only one area of the entire 35-page document of the 2018 LCME standards that stated anything explicitly about integration of a curriculum. A "coherent and coordinated curriculum" should have three things:

> "1) the logical sequencing of curricular segments, 2) coordinated and integrated content within and across academic periods of study (i.e., horizontal and vertical integration), and 3) methods of instruction and student assessment appropriate to the achievement of the program's educational objectives. (Element 8.1)" (pg. 23).

Another reason for reform is the overwhelming amount of foundational knowledge that must be learned in two years, combined with the reduction in course hours (Brooks et al., 2015). Course hour reduction was originally proposed by the GPEP Report (Association of American Medical Schools, 1984), the ACME-TRI Report (Swanson et al., 1993), and the report by Cooke et al. (2010). Those reports stated that students should learn how to work independently, but that too much time in the classroom does not allow for independent learning. They also recommended a reduction of lectures by one third or even one half, though that time could be replaced with other activities to promote independent learning, such as problem-based learning sessions.

Course hour reduction was specifically noted for the anatomical disciplines of gross anatomy, embryology, microscopic anatomy, and neuroanatomy by Drake et al. (2002, 2009, 2014) and McBride and Drake (2018). These articles included information from surveys sent out by Richard Drake and his colleagues; the surveys were sponsored by the American Association of Anatomists (AAA) and were distributed to course directors of allopathic and osteopathic medical schools in the United States. Various survey questions asked about how those anatomical disciplines were taught (stand-alone course, part of an integrated course), total course hours, number of laboratory and lecture hours, number and type of assessments, and type of lab experiences.

Some of the results that were found from those surveys included a statistically significant reduction of course hours in the anatomical disciplines from 2002-2009. These numbers held steady from 2009-2014, but for gross anatomy and microscopic anatomy, there was a statistically significant decrease in course hours from 2014-2018. Cadaver dissection was still a popular lab experience for students from 2002-2018, with around two-thirds of schools reporting they still used cadaver dissection. One of the prominent results of those surveys was about how those disciplines were incorporated into their school's curriculum, whether part of a fully or partially integrated curriculum, or as a stand-alone course. The surveys from 2002 did not collect these data, but data from the 2009 survey showed a range of 30-49% of integration of the disciplines. This number increased a bit in the 2014 survey, with a range of 53-64% (though only 25% of reporting schools integrated neuroscience that year). However, in 2018, the numbers of medical schools integrating their anatomy disciplines remarkably increased to between 94-98% being partially or fully integrated. This speaks to the major shift in curricular reform occurring at medical institutions at this time in history.

Effects of Curricular Reform in the Anatomical Disciplines

We now know that the anatomical disciplines have been changed due to curricular reform. There has been reduction in course hours, and there has been more integration of courses. In recent years, there have been many articles published on medical schools that have completely overhauled their curriculum, or at least completely changed an anatomy course. In this section, some of the effects that this curricular reform has had on the anatomical disciplines will be reviewed.

Anatomical Science Faculty Perceptions about Medical Curricular Reform

Anatomical science faculty members are most commonly the ones who are tasked with delivering the basic anatomical science information to the students, whether it be through didactic lectures, problem-based learning sessions, or in labs. Research on the extent of faculty involvement in curricular reform is very sparse. There are also only a few studies which examined medical faculty perceptions of curricular reform. The focus in most research is more on student perceptions of reform. Muller et al. (2008) did conduct interviews with both students and faculty who were within a newly integrated medical school program at the University of California - San Francisco Medical School. Faculty perceptions focused on the hardships with interdisciplinary collaboration among faculty who had to work together in an integrated course. Many times, personalities and teaching styles did not mesh well, so faculty did not enjoy teaching with certain people.

Medical Student Perceptions about Medical Curricular Reform

Medical students may also have issues with the interdisciplinary collaboration, but in a different manner. Students have complained about redundancies in lectures, lack of true integration of the material, and receiving advanced content before learning basic concepts (Muller et al., 2008).

Students may also be frustrated with the lack of direction given to them. Many medical institutions use self-directed and independent learning now, but *too* much independence can be a negative. Students want a balance between complete independence in their learning and wholly didactic lectures (Whelan et al., 2015).

Despite complaints about faculty involvement in their education, students have found, through case studies and interaction with patients in the clinical setting, that they are able to retain basic science information (Muller et al., 2008). Heiman et al. (2018) found that students in an integrated organ systems-based curriculum at Northwestern University School of Medicine increased their self-confidence going into their clerkships due to having more opportunities to engage with patients in a clinical setting.

Some medical schools are also willing to look at negative complaints and change the curriculum to rectify what is not working. For instance, Morehouse School of Medicine restructured their curriculum in 2007 (Klement et al., 2011). In one of their courses, entitled "Human Morphology," the material was condensed into a 7-week course, as opposed to the original full semester course. Many students were failing the course after the first exam. That prompted some faculty to create an in-course enrichment program to help those students. By the end of those 7 weeks, all the students were passing the course. And at the end of the school year, a survey administered to students showed a 74% satisfaction rating of the new curriculum. Continuous feedback by students is also occurring at institutions such as the University of Delaware, which relies on the feedback of 8-10 student evaluators who represent their class and provide both positive and negative feedback on each module of the curriculum to their module director and associate dean of curriculum, including such long term effects as involving the students in simulation training even earlier in their careers (Goldfarb and Morrison, 2014).

Student Assessment of Performance

Assessment of student performance through course examinations as well as through the National Board of Examiners (NBME) anatomy subject examinations and anatomy areas of the United States Medical Licensing Examinations (USMLE) help provide empirical evidence on whether or not curricular changes are impacting acquisition and retention of anatomical science information. The NBME subject exams are administered by the NBME to LCME-accredited schools across the US and Canada. They most often serve as final examinations for the various courses a student takes in medical school. Since courses and curricula vary from school to school, these subject exams vary as well (National Board of Examiners, 2018). The NBME was formed in 1915 and delivered its first exams in 1916. These exams were initially essay format, but they were changed to be solely multiple-choice format by the late 1980s (Melnick et al., 2002).

The USMLE consists of three licensing examinations, often referred to as “Step exams.” The first exam (Step 1) is typically administered after the second year of medical school, the second (Step 2) is normally administered during the fourth year of medical school, and the third exam (Step 3) is often administered at the end of the first year of residency (USMLE, 2019). These examinations assess physicians’ knowledge and patient-centered medical skills. Each of these Step examinations are the same for each medical school, unlike the NBME exams, which vary across medical schools. The passing of these three Step exams is one of the major stages in receiving licensure to become a physician. Students must receive a passing score on the Step 1 exam (typically taken after the pre-clerkship years) before they can move on to their clerkship years. The NBME Step 1 numeric score is used to residency program directors to screen and rank applicants. A student’s Step 1 score often is the source of great angst, as a less than adequate score may prevent a student from pursuing a competitive residency (e.g., residency in plastic surgery or dermatology).

Some research on the subject of curricular reform and student performance on USMLE and NBME subject examinations have found significant differences on examination scores, when comparing pre-curricular reform and post-curricular reform. Klement et al. (2017) found not only an increase in NBME anatomy scores in their integrated curriculum compared to their traditional curriculum at their institution, but the authors also discovered that each year since the integration occurred, NBME anatomy scores increased. Others, however, found no significant differences between type of curriculum and examination scores (Cuddy et al., 2013; Heiman et al., 2018).

Cuddy et al. (2013) surveyed 54 medical schools about their number of course hours, how the anatomies were taught (part of integrated curriculum or stand-alone course) and USMLE Step 1 and Step 2 scores. They also reviewed gross anatomy sub-scores on USMLE Step 1. It was found that the number of course hours and type of curriculum was not significantly related to USMLE scores, after controlling for MCAT scores and undergraduate GPA. Hecker and Violato (2009) looked at data from the USMLE and AAMC for 116 medical schools from 1994-2004 and found that type of curriculum accounted for less than 1% of variation of student performance on the USMLE, again controlling for MCAT scores and undergraduate GPA.

From the data above, the main variable that predicts scores on the USMLE and NBME exams could very well be MCAT scores. Donnon et al. (2007) found a medium to large predictive validity for students’ MCAT scores. Students who enter medical school are all very high achieving individuals. They will all have great undergraduate GPAs and recommendations, but the MCAT may divide the higher achieving students from the lower achieving students through an empirical manner (Donnon et al., 2007). The MCAT has been seen as an important predictive variable in the USMLE Step 1 and Step 2 exams (Gauer et al., 2016; Haught and Walls, 2004).

While MCAT scores do appear to be a predictive variable on a student's performance on NBME subject and USMLE medical licensure exams, this doesn't mean that students with a lower MCAT will necessarily do poorly on those exams. What it means is that students will do what they need to do to pass an exam, despite the type of curriculum that they encounter, and despite all of the other variables in their way – this is why the pass rates for the USMLE Step exams are between 94% and 97% (United States Medical Licensure Examination, 2019).

There has recently been a call to remove the numerical scoring of the Step examinations, especially the Step 1 exam, which has a major emphasis for residency applications. Chen et al. (2019), a group of concerned medical students, stated they want the Step 1 exam to eliminate the reporting of numeric scores. The authors also stated that the exam creates a "Step 1 Climate" with a negative impact on medical education, student disparities (including not being able to afford Step 1 study materials), and mental health. Additionally, there have recently been more informal discussions about additional revisions to the timing and organization of the Step examinations, but nothing has been published on it thus far (Valerie O'Loughlin, personal communication, April 23, 2019).

Anatomical Science Curricular Reform after Pre-clerkship Years

As was discussed previously, there are many different ways the anatomical sciences may be incorporated into an integrated curriculum. These different methods of integration do not appear to have a large effect on exam scores (Cuddy et al., 2013; Hecker and Violato, 2009; Klement et al., 2011), but exam scores are not the sole factor in the successful education of a medical student.

Lifelong learning is a goal of both medical educators and physicians. Lifelong learning is defined as "learning throughout the lifespan," particularly in adulthood (Jarvis, 2004, pg. 281).While the pre-clerkship years are the focus of this dissertation research, this literature review would not be fully complete without mentioning clinical education in the clerkship years, as well as GME, and even continuing medical education (CME) in the years after residency (Cooke et al., 2010). It is imperative that students receive some additional education in the anatomies to review their knowledge in those disciplines. Researchers have started to take note on this crucial aspect of medical education (Fillmore, 2015).

This additional education can be accomplished starting with electives in the third and fourth years of medical school which utilize vertical integration to bring back anatomy to the clinical years (Brooks et al., 2015; Lazarus et al., 2014). Additionally, Vanderbilt University implemented what they refer to as "Integrated Science Courses" which combine both classroom and workplace learning (Dahlman et al., 2018). Other ways that anatomy can be brought back into the clinical years, during residency training, and years beyond include cadaver dissection workshops (Macchi et al., 2003), ultrasound workshops (Dreher et al., 2014; Kelm et al., 2015), and radiologic imaging sessions (Gunderman and Wilson, 2005; Labranche et al., 2015).

Education should be an ongoing process. It should not stop after the four years of medical school have ended. Medical students should have the opportunity to improve upon their knowledge within the anatomical disciplines throughout their career. This can be done though dissection workshops, ultrasound and radiographic training sessions, and other modalities of education.

Conclusion

From moving from apprenticeships to formal institutions, to increasing the term from two years to four years, and to moving away from traditional, discipline-based education to a more integrative medical education, the history of medical curricular reform has evolved tremendously. Medical education will continue to evolve for the foreseeable future.

Many medical education research studies have investigated the impact of curricular reform on the anatomical sciences, but with a very minimal scope. Some studies have only looked at their own medical institution (Klement et al., 2011; Lazarus et al., 2014). Other studies have looked at multiple institutions, but for only one aspect of the impact of curricular reform, such as on USMLE Step scores (Cuddy et al., 2013; Hecker and Violato, 2009). No one study has looked at the impact of the actual anatomical sciences and perceptions of faculty members and students on curricular reform at their institution.

This research looks at those aspects of medical curricular reform described above that have not yet been researched thoroughly. The next chapter details the methodology that was followed in order to answer the following questions:

1. How do American medical schools granting a medical doctorate degree classify their curricula?
2. See below

   a. What number of allopathic medical schools in the United States have undergone any major curricular reform within the last 10 years (since 2007)?
   b. What were the medical schools' stated reasons for curricular reform at their institutions?
3. How are anatomical science classes organized within medical school curricula that have been recently revised?
   a. Does the anatomy content coverage increase, decrease or stay the same for classes involving the anatomical sciences?
   b. How does the curricular revision change the amount of anatomy lab experience and type of lab experience in the anatomical sciences?
   c. How does the curricular revision change the anatomy lecture experience in the anatomical sciences?
   d. What are faculty perceptions of curricular reform at their institution?
4. What are medical student and faculty perceptions of curricular reform at a case study institution (Indiana University School of Medicine-Bloomington), and how do they compare to the US landscape?
   a. How do first-year medical students at IUSM-B perceive the newly implemented medical curriculum that began in fall 2016?
   b. How do anatomy faculty perceptions of curricular reform at IUSM-B compare to anatomy faculty perceptions from other US medical schools?

CHAPTER 3: RESEARCH QUESTIONS AND METHODOLOGY

This chapter outlines the specific questions that are addressed by this research, followed by a general overview of the methodology used, and it ends with a description of the specific instruments and methods used to answer the research questions. The central aim for this study was to investigate the impact of medical curricular reform on the anatomical science disciplines in the United States of America.

Research Questions and Hypotheses

Research Question 1: How do American medical schools granting a medical doctorate degree classify their curricula (e.g., horizontal, vertical, or spiral integration, problem-based learning curriculum, basic science integration, organ-systems based, etc.)?

Hypothesis: Medical schools will have many different ways to classify their curricula. It is hypothesized that the term "integration" will be used most commonly, followed by the terms horizontal, vertical, and/or spiral curricular reform.

As seen in the review of literature in Chapter 2, there is no single definition for curricular reform and integration among medical schools. Table 3.1 describes some of the common curricular definitions and examples of these terms, and the selected citations that either define these terms or provide examples of how the curriculum is utilized.

Table 3.1: Definitions and Examples of Commonly Used Terms in the Medical Curriculum

Medical Curricular Term	Example	Selected Citations Where Terms are Defined
Types of Curricular Approach	How the curriculum is organized overall	
Traditional approach/Discipline approach/Conventional/Lecture-based	Teaching pre-clerkship courses by subject (e.g., Anatomy, Physiology, Biochemistry)	Cooke et al., 2010; Custers, 2010; Flexner, 1910; Harden et al., 1984; Hecker and Violato, 2008; Papa and Harasym, 1999; Schmidt et al., 1996
Organ systems approach	Teaching pre-clerkship courses by organ system (e.g., Renal, Cardiovascular, GI)	Brooks et al., 2015; Cooke et al., 2010;Hecker and Violato, 2008; Hecker and Violato, 2009; Hopkins et al., 2015; Muller, 2008; Papa and Harasym, 1999; Schmidt, 1996
Problem based approach	Including problem-based case studies into most of the curriculum, with only minimal lecture time	Barrows and Tamblyn, 1980; Des Marchais, 1992; Donner and Bickley, 1993; Gurpinar et al., 2005; Hartline et al., 2010; Hecker and Violto, 2008; Hmelo, 1998; Koh et al., 2008; Nandi et al., 2000; Newble, 1986; Papa and Harasym, 1999; Ransom et al., 2017; Schmidt et al., 1996
Clinical presentation approach	Including signs and symptoms within case studies into most of the curriculum, with only minimal lecture time; similar to problem-based curriculum but it focuses on about 125 clinical presentations (please see Review of Literature chapter of this dissertation for more explanation)	Hecker and Violato, 2008; Hecker and Violato, 2009; Mandin and Dauphinee, 2000; Mandin et al., 1995; Papa and Harasym, 1999; West et al., 1991; Woloschuk et al., 2004

Integration of the curriculum	Incorporation of different concepts together, (concepts can be medical subjects, topics, diseases)	
Horizontal integration	Integration within a single year; this integration may be integration of concepts, subjects, etc.	Halliday et al., 2015; Klement et al., 2017; Vidic and Weitlauf, 2002
Vertical integration	Integration across all years (e.g., revisiting anatomy, a typical 1st year subject, in a third-year clerkship)	Brooks et al., 2015; Lazarus et al., 2014; Wijnen-Meijer et al., 2009
Spiral integration (also referred to as a combination of horizontal and vertical integration)	Combination of horizontal and vertical integration	Brauer and Ferguson, 2015; Heiman et al., 2018; Quintero et al., 2016; Wilkerson et al., 2009

Research Question 2a: What number of allopathic medical schools in the United States have undergone any major curricular reform within the last 10 years (since 2007)?

Research Question 2b. What were the medical schools' stated reasons for curricular reform at their institutions?

The hypotheses for these research questions are as follows:

Hypothesis 2a: The proportion of responses of medical programs that have undergone curricular reform in the last 10 years will be greater than those that have not.

Hypothesis 2b: The most common reason for curricular reform will be to meet the Liaison Committee on Medical Education (LCME) standards for accreditation.

There has been a trend of the increased usage of "integrated curriculum" in the literature since the early 1980s (Brauer and Ferguson, 2015), and an even greater rise in the last 10 years. The standards set forth by the LCME, the accrediting body for medical schools in the United States and Canada, may be a contributing factor for the increase in integration and general curricular reform at medical schools. Prior to 2012, there was no mention of integration in the LCME standards (Liaison Committee on Medical Education, 2012). After that year, the general phrase to describe how a medical school should organize it's curriculum was to be "coherent and coordinated'' and ''integrated within and across the academic periods of study'' (Liaison Committee on Medical Education, 2018, pg. 12).

Many medical schools have revised their curricula for a variety of reasons. Many, as just mentioned, have changed their curricula in order to meet LCME standards for accreditation (Heiman et al., 2018), while others have changed their curricula to accommodate the rising amount of medical knowledge content required to be taught

(Mahan and Clinchot, 2014). Other reasons for curricular reform include increasing active-learning methods in the classroom (Kerby et al., 2011) and exposing students to clinical experiences earlier (Dezee et al., 2012).

Research Question 3: How are anatomical science classes organized within medical school curricula that have been recently revised?

More specifically, this research was subdivided into the following questions.

a. Does the anatomy content coverage increase, decrease or stay the same for classes involving the anatomical sciences?

b. How does the curricular revision change the amount of anatomy lab experience and type of lab experience in the anatomical sciences?

c. How does the curricular revision change the anatomy lecture experience in the anatomical sciences?

d. What are faculty perceptions of curricular reform at their institution?

The hypotheses for these research questions are as follows:

Hypothesis 3: Many of the anatomical sciences in majorly revised curricula will not be taught as stand-alone courses. Rather, they will be combined with another course or taught within a systems-based unit.

Hypothesis 3a: The amount of time of instruction and number of topics related to gross anatomy topics, including lab and lecture, will be decreased in medical school programs that have undergone curricular reform. The amount of time of instruction and number of topics related to microscopic anatomy and neuroanatomy in medical schools that have undergone curricular revision will not change.

Hypothesis 3b: The amount of time dedicated to and type of lab experience in revised curricula will vary with medical schools and type of classes because no one size fits all.

Hypothesis 3c: The lecture experience in a revised curriculum will include many varieties of active learning for all anatomical disciplines. Additionally, the lecture experience will change to a large extent in all anatomical disciplines, including having reduced hours.

Hypothesis 3d: Faculty member perceptions of their revised medical curriculum will be strongly correlated with the amount of involvement they have had with the planning and development of the curricular reform. Additionally, faculty perceptions about the curriculum will be more strongly correlated in curricula that have been implemented for longer than five years.

Research questions 1, 2 and 3 were designed to be answered by way of distributing surveys to anatomical science faculty members of LCME-accredited allopathic medical schools in the US. They were also designed to be answered through in-depth discussions with those faculty members who consented to partake in an interview.

Faculty surveys that examine anatomical science content coverage and length are not novel. Drake et al. (2002, 2009, 2014) and McBride and Drake (2018) were one such group of researchers who distributed surveys to US medical institutions asking about how the basic science courses (gross anatomy, microscopic anatomy, neuroanatomy, and embryology) are incorporated into the school's curriculum: part of an integrated course, stand-alone course, or a mixed approach. As of the newest edition from 2018, 94% of schools surveyed said gross anatomy was part of a fully or partially integrated course.

The survey reported similar numbers for microscopic and neuroanatomy courses, with 98% of respondents saying the microscopic anatomy course was fully or partially integrated, and 96% saying the neuroanatomy course was fully or partially integrated (McBride and Drake, 2018). Those surveys also showed that the total number of course hours had declined from 2002-2018, particularly in the number of hours dedicated to teaching lab material.

After an anatomy course has gone through curricular revision, and likely has had its contact hours cut, educators must find ways to deliver the anatomical content with those shortened contact hours. For example, Thompson and Lowrie (2017) explained how the microscopic anatomy course at the University of Cincinnati College of Medicine had shifted from in-person labs to remote learning activities where students would watch videos of the histology information at their own leisure and could view the videos as many times as they wanted.

Despite the norm of reducing basic science (including anatomical science) contact hours for medical school programs undergoing curricular reform, cadaver dissection practices are still quite prevalent (McBride and Drake, 2018) due to the benefit of 3D spatial interaction (Lempp, 2005). Some schools were successfully able to retain most of their dissection experience even in an integrated curriculum (Klement et al., 2011), while other schools incorporated dissection with other learning modalities such as team-based learning (Johnson et al., 2012). Ultrasound (Brooks et al., 2015) and other medical imaging may be used along with dissection to further demonstrate 3D relationships (Kisch et al., 2013).

The hypothesis for 3d will be tested using quantitative data through close-ended questions on the surveys. However, qualitative data about faculty perceptions will also be collected from open-ended questions on the surveys as well as through interviews with these faculty members and will further serve to inform the quantitative findings and thus will not have a priori hypotheses.

Research Question 4: What are medical student and faculty perceptions of curricular reform at a case study institution (Indiana University School of Medicine-Bloomington), and how do they compare to the US landscape?

A case study at the Indiana University School of Medicine-Bloomington (IUSM-B) was conducted to gather information on a specific medical school that had recently undergone curricular reform. IUSM-B was the only campus in the IU medical school system chosen for this case study because the author had relatively easy access to both students and faculty, and she had explicit knowledge about how exactly the anatomical science courses were run at this campus – both prior to curricular reform (fall 2016) and after curricular reform.

More specifically, this research question was subdivided into the following more specific questions:

4a. How do first-year medical students at IUSM-B perceive the newly implemented medical curriculum that began in fall 2016?

4b. How do anatomy faculty perceptions of curricular reform at IUSM-B compare to anatomy faculty perceptions from other US medical schools?

The hypotheses for these research questions are:

Hypothesis 4a: Perceptions of students at IUSM-B about the medical curricular reform will skew slightly negatively.

Hypothesis 4b: In general, anatomy faculty member perceptions of their revised medical curriculum will be strongly correlated with the amount of involvement they have had with the planning and development of the curricular reform.

The hypotheses above are in reference to the quantitative data collected through surveys administered to medical students at IUSM-B. The qualitative data from this research, including open-ended questions on those surveys and focus groups conducted with both the IUSM-B medical students and IUSM-B anatomical science faculty will serve to further inform the quantitative data, and thus will not have a priori hypotheses.

Much data in the area of perceptions of students of medical curricular reform come from student evaluations. These evaluations may ask questions which gather quantitative data, such as asking the student how much they agreed with various questions, often using a 5-point Likert scale. For instance, Lazarus et al. (2014) examined a fourth-year musculoskeletal anatomy elective and had a survey question which asked the extent to which the students agree with the statement of *I found this course has helped me feel more confident in applying anatomy to the clinical setting*. The mean response to that question was a 4.5/5 with 5 meaning strongly agree with the statement.

Student evaluations may also have open-ended questions, looking for student feedback on the course. Klement et al. (2011) collected open-ended responses from students that reflected course content, material coverage, and lecture time. One comment related to coverage and course content was "I liked that the material wasn't duplicated.

When it was duplicated it was done appropriately and at the right time. The only thing I wish you could do is lengthen the Biochemistry and shorten the Gross."

While research on students' perceptions of their medical curricula are prevalent, there have been few studies about faculty perceptions of curricular reform. Muller et al. (2008) is one of the only studies to report on students and faculty perceptions about their integrated curriculum. The authors interviewed student and faculty members at the University of California-San Francisco (UCSF) Medical School to gauge their thoughts on an integrated curriculum. Four themes emerged from their grounded theory analysis of the interviews: interdisciplinary teaching, interdisciplinary collaboration, building curricular links, and sequencing and framing curricular content. Specifically, and to contrast with the Klement et al. (2011) student comments, students at UCSF stated that some subjects in the curriculum, such as anatomy and histology, were not well integrated and, even though they were placed in an integrated course, many lectures were still discipline-specific.

The primary theme that emerged from faculty from the Muller et al. (2008) study was the challenge of dealing with interdisciplinary collaboration while teaching in an integrated curriculum. From this research, it appeared as if most faculty were involved in the planning of the curriculum, but that communication was a primary issue. Faculty from basic sciences and those from the clinical aspect of the medical curriculum did not share the same pedagogical practices while teaching, so there was some disjointedness in some of the courses, which may have led to some of the negative student perceptions. While this study is very important, especially for being one of the only ones to interview faculty and medical students, it is over 10 years old and only involved a small sample size (three curriculum leaders, four course directors, and six medical students). More research in this area is needed.

This lack of evidence from students and faculty members, the very people who experience and benefit from the medical curriculum, is disheartening. It is this lack of evidence about the benefits of medical curricular reform that was one of the driving features of this dissertation. It's the author's hope to add to the literature with the findings from this research.

This next section will discuss a general overview of the methods used to answer the above research questions. The section that follows then will discuss the specific processes used to answer those research questions.

General Methodology to Answer the Research Questions

The research focus of this dissertation was to study the impact of medical curricular reform on the teaching and learning of the anatomical sciences. Not only did the author want to know how specifically the anatomical science courses have changed due to curricular reform, but she also wanted to ascertain both faculty and student perceptions about that curricular revision. These types of inquiries lead to diverse and creative research methodologies in order to collect data that will help supplement the current body of knowledge in medical education.

Data collected for this research included utilizing both quantitative and qualitative methods, which are described in Table 3.2. **Quantitative methods** involve collecting data and generalizing it across groups of people or to explain a phenomenon using statistical methods. Quantitative data collected utilize a validated research instrument. In educational research, that is often a survey (Bergman, 2008). **Qualitative methods** involve the analysis of language, written or oral, and actions to determine patterns, themes, or theories in order to provide insight into certain situations (Boudah, 2010).

Table 3.2: Overview of Quantitative and Qualitative Methods of Data Collection

Type of Method	**Description**	**Examples from this research**
Quantitative	Collect numerical data and analyze using statistics to generalize to group of people or explain phenomenon	Likert scale questions (1-5) Scale of perceptions (1-10) Number of medical students
Qualitative	Analysis of language to look for patterns and themes	Website analysis Interviews Open-ended questions in surveys

This research used a combination of quantitative and qualitative measures to answer the research questions. This is called **mixed methods research** (Bergman, 2008). As an example, the faculty survey asks both quantitative and qualitative questions. This mixed methods approach allows for **data triangulation**, which is the comparison of findings about the same research questions using different inquiry methods. Triangulation also helps to improve the validity of a study (Bergman, 2008), for instance to check that what a participant stated in his or her survey responses matched with what he or she stated in the interview. Specifically, **sequential explanatory mixed methods** research was conducted, whereby quantitative data is collected first, and qualitative data is collected second. The qualitative data serves to further explain and interpret the findings from the quantitative data (Creswell, 2012).

Mixed methods research, utilizing a dual quantitative and qualitative research design, provides a greater depth to the understanding of the research problem and questions and a greater comprehensive view than either method could produce alone

(Creswell, 2012). In pursuance of adding valuable insight to the current body of knowledge that was discussed in the last chapter, the researcher decided to collect various types of data to provide a comprehensive understanding on how the anatomical sciences are impacted due to curricular reform.

Table 3.3 outlines the different data sets that were studied for this dissertation research and summarizes the types of analyses conducted on the data. For example, in part 2 of the research, a faculty survey was distributed, where Likert scale and other scaled quantitative items were asked, and this survey addressed research questions 2a,2b,3,3a,3b,3c,3d, and 4b. Both quantitative and qualitative methods of analysis were used for these data and are described in the following paragraphs.

Table 3.3: Data Analysis for Dissertation Research

Part of the Research	**Data to be collected**	**Population Size**	**Addresses this research question**	**Timeline of data collection**	**Types of data analysis**
Part 1	Website analysis of US allopathic Medical School curricula	145	1	Spring 2017	**Qualitative:** • Content analysis
Part 2	US Medical School Faculty Survey	~435	2a, 2b, 3,3a, 3b,3c,3d,4b	Fall 2017-Summer 2018	**Quantitative:** • Descriptive statistics • Frequencies • Chi square test of independence • Spearman's correlation • Mann-Whitney U • Kruskal-Wallis test

					Qualitative: • Content analysis
Part 2	Medical School Faculty Interviews	~438	2a, 2b, 3,3a, 3b,3c,3d,4b	Spring 2018-Summer 2018	**Qualitative** • Thematic analysis
Part 3	IUSM-B first-year medical student survey	72	4a	Summer 2017 and Summer 2018	**Quantitative:** • Descriptive statistics • Frequencies **Qualitative:** • Content analysis
Part 3	IUSM-B first-year medical student focus group	72	4a	Summer 2017 and Summer 2018	**Qualitative** • Thematic analysis
Part 3	IUSM-B faculty focus group	4	2a, 2b, 3,3a, 3b,3c,3d,4b	Summer 2017	**Qualitative** • Thematic analysis

For both the faculty and student survey data, quantitative data were analyzed by using descriptive statistics and frequencies to identify a general trend of the data. For only the faculty survey, the following statistical tests were run: a correlation matrix, using Spearman's correlation and a Chi square test of independence, which were used to explore the faculty survey responses which related most with each other; a Mann-Whitney U test and Kruskal-Wallis test which were run to discover if there were statistically significant differences in the data (Field, 2013). For a closer look at precisely what survey variables used which statistical measure, please see the descriptions under *Faculty Survey Analysis* in this chapter.

The open-ended questions from the surveys, as well as the website analysis of medical curricula collected qualitative data and were analyzed by using a **content analysis**, as described by Bengtsson (2016) and Erlingsson and Brysiewiz (2017). With content analysis, it is imperative to read the text many times through to gain a general understanding on what is being discussed. From there, **meaning units** are created, which are the direct quotes from the text. **Condensed meaning units** are then created, which are more of a paraphrase from the direct quote. From those, **sub codes** are created, which are generally considered a label that can be one or two words long, and then **codes** are generated, which is where similar sub codes are grouped together. Within content analysis, sub codes and codes can be tallied, so that there is a quantitative component within the qualitative analysis.

Another type of qualitative analysis that was used for this research was thematic analysis. **Thematic analysis** is a type of qualitative analysis that involves searching for recurring ideas (or themes) in the data, after all data is collected. This type of analysis allows for a rich and deep understanding of the data to discover patterns and develop themes (Jason and Glenwick, 2016). Faculty interviews as well as faculty and student focus group data were analyzed using this qualitative approach.

In thematic analysis, there are a few steps one should take to analyze the data. Step one is to **immerse oneself in the data** by transcribing the qualitative data while taking notes on patterns, which can lead into themes later. Step two is to **generate initial codes** after familiarizing oneself with the data, and this can enable the organization of data into **categories**, which are common codes grouped together. Step three is to **search for themes** by considering how codes can fit together into broader themes. Step four is to **review the themes** and refine them. This can be accomplished by reading through the data again to see if any codes were missed. Step 5 is to **define and name themes** by identifying a central idea captured by the theme. Finally, step 6 is to **produce the report** by going beyond just the description of the data to make an argument. The production of the report is the part that will tell the story from all the codes, themes, and ideas (Jason and Glenwick, 2016).

For both content analysis and thematic analysis, there are two approaches that can be taken to code and categorize the data: **deductive** and **inductive** analysis. With deductive analysis of qualitative data, it is a top-down approach. The researcher brings a set of concepts, ideas, or topics to the data that are used to interpret and code the data. **A priori codes** are found from the data, where predetermined codes are developed before looking at a data set. For example, common codes or trends found from a literature search on a certain topic are considered a priori codes. In contrast, inductive analysis of qualitative data uses a bottom-up approach. Here, the interpretation of the data and the codes are from the actual data set. The codes generated from the data are referred to as **emergent codes** (Bengtsson, 2016; Braun and Clarke, 2019). The author used deductive followed by inductive analysis for all the qualitative data from this research. Braun and Clarke (2019) stated that there were limitations of each analysis when used separately, such as the fact that researchers always bring something to the data when it is analyzed, so it can never be truly inductive. Another limitations of only using one analysis is that there is always going to be some construct that emerges from the data, so it can never be truly deductive. That is why the author used both inductive and deductive analysis of the qualitative data.

It was decided by the author to do a content analysis of the survey data because the author believed that finding the frequency of codes in the data would help explain some of the responses for the quantitative data. For example, on the faculty survey, if so many faculty members responded to the Likert Scale question collecting quantitative data which stated "I feel like this medical program is producing adequately-trained medical doctors" with a more negative response: "strongly disagree," it would be worth looking for an explanation of why this was so. Coding the data from the open-ended question associated with the previous statement "Please explain," the author would look for the frequencies of more negatively associated codes from the respondents.

The author decided to conduct a thematic analysis on the interview and focus group data, as opposed to using other qualitative methodologies of data collection, such as grounded theory, because thematic analysis looks for themes from the data itself, rather than beginning with a theme. **Grounded theory** is a type of qualitative analysis model which is very similar to thematic analysis; however, grounded theory derives a theoretical model from the data (Jason and Glenwick, 2016). In contrast, **thematic analysis** derives multiple themes, not just one theory, from the data. As the author believed the data would contain many emerging themes in the domain of curricular reform, it was decided to conduct a thematic analysis with the data.

The next sections of this methodology chapter, labeled Parts 1-3, will discuss in detail the specific methodology used to answer the research questions from above. Part one details the website analysis of medical school curricula. Part two details the composition, recruitment and distribution, and analysis of the faculty surveys and interviews. Part three discusses a case study that was conducted at IUSM-B with students and faculty there. This part includes student surveys and focus groups and a faculty focus group.

Part 1: Website Analysis of Medical School Curricula

The first part of this study involves researching the curriculum of each LCME-accredited allopathic medical school in the United States. Appendix A lists the information collected from this research. This part helped to answer the following research questions:

Research Question 1: How do American medical schools granting a medical doctorate degree classify their curricula (e.g., horizontal, vertical, or spiral integration, problem-based learning curriculum, basic science integration, organ-systems based, etc.)?

A website analysis of the curriculum at each allopathic medical school in the United States (excluding Puerto Rico) was conducted by the author. It was decided to not include osteopathic medical schools because of the belief that the type of curriculum found at those schools would be different enough that it would be considered a confounding variable. Osteopathic schools also are not accredited by the LCME but by a different accrediting body. In addition, since one of the hypotheses of this research was that a main reason for medical school curricular reform was to meet LCME accreditation standards, it would not make sense to include osteopathic schools in this research.

The data collection and analysis of the medical curricula took place over the course of around four months, beginning in February 2017 with completion in June of 2017. It began with going to the Association of American Medical Colleges (AAMC) website on student enrollment (Association of American Medical Colleges, 2017) and viewing the names of the medical schools listed. An alphabetical list of these schools was created in Microsoft Excel (2016). The medical schools were listed in alphabetical order on the basis of the state abbreviations, not the whole name of the state. Abbreviations were used so as to not have to type out the name of every state multiple times. Within the states that were in alphabetical order, the names of the medical schools were also placed in alphabetic order by the entire name of the medical school. For instance, many people may know the medical school at Eastern Carolina University as Eastern Carolina University School of Medicine. However, the entire name is “The Body School of Medicine at Eastern Carolina University.” So, instead of beginning at the letter “E,” the school name began at the letter “B” (“the” was not used in the alphabetical listing of the medical schools).

The Google search engine tool was then utilized to find the web page of each medical school. The next step was to go to each school’s website and find the page on which the curriculum was discussed, which served as the web page that was placed in Appendix A. If the entirety of the curricular description was located on multiple web pages, the author placed the web page which contained the primary descriptors of the curriculum within Appendix A. Regional campuses (if applicable) were also found on the website and added to the spreadsheet, along with the location (city and state) of the main campus. Total student population for each medical school, which was documented on the AAMC website (Association of American Medical Colleges, 2017) was also included.

The author then split the medical schools into thirds based on size of the medical school, so that there would be about equal numbers in each category. A small-sized medical school was less than 485 students and consisted of forty-eight medical schools. Forty-seven medical schools were categorized as medium-sized with between 485-725 medical students. Finally, forty-eight medical schools were categorized as a large size with greater than 725 medical students. This population data was not used for this specific research; however, the hope is to use these data for future research. This is discussed more in conclusions chapter of Chapter 7.

The author also discovered in which region the university was located. Medical schools, and the states or Canadian provinces that they are a part of, were divided by the Association of American Medical Colleges (AAMC, 2018) into four regions. These four regions are Central, Northeast, Southern, and Western. The author counted the number of medical schools (excluding Canadian medical schools or medical schools from Puerto Rico), and placed them into one of the four regions. These data are used in Chapter 5 to see how many medical schools from each region are represented from the survey.

The input of the medical school data involved typing a brief verbatim description of the curriculum in the Excel spreadsheet. The University of Miami Leonard M. Miller School of Medicine located in Miami, FL, will serve as an example on how this website analysis was completed for all medical schools. This example is presented both in this chapter as well as Chapter 4. Part of the curriculum at the University of Miami was described on the website as follows:

> "…integrates courses and learning at three levels: a) integrate the basic sciences; b) integrate the basic sciences and clinical sciences; and c) integrate the study of normal structure and function with the study of abnormal, disordered structure and function" (University of Miami Miller School of Medicine, 2018).

While the author wrote a verbatim description of the curriculum from the medical school's web page, it was an abbreviated description about the important parts of the curriculum. For the content analysis of this website data, the author first used deductive content analysis followed by inductive content analysis. The a priori codes from the deductive analysis were considered "first pass codes." For this research, the first pass codes seen in Table 3.4 were seen in previous studies about medical curricular reform (see Chapter 2 under *20th Century Medical Curricular Models*). For the University of Miami example above, the first pass generated codes of “integrate” and “basic science.” This coding allowed the author to focus on the sentences of the curricular description from each medical school which involved the organization of the basic science courses and any integration that was occurring in those courses.

Coding for the first pass of each website curricular description included printing out the spreadsheet of the medical schools and their curricular descriptions and then highlighting each of the codes using different colors of pen or marker. This helped keep a visual track of all the different coding variables.

After the first pass of each website, the curricular descriptions of each medical school were analyzed again using the same process of highlighting with a pen or marker, and then a larger list of codes was developed using inductive content analysis. This approach involved the author going through the data multiple times in order to acquire reliable analysis of the data, so that no key codes were missed. Bengtsson (2016) and Downe-Wambolt (1992) state that researchers should start from different pages while going through the data to further increase the reliability of the data. During the subsequent passes of the data, the author began on different schools, rather than going straight through them alphabetically. After going through the data from the different medical schools, a newer, more refined list of codes was generated, which was considered the second pass of the data.

Table 3.4: Description of Codes and Sub Codes used for Medical School Website Analysis

First Pass Codes	Integration/integrated/integrate
	Systems
	Discipline
	Basic Science
	Describing the curriculum as "new" in the last 10 years
Second Pass Sub Codes for Integration	Vertical integration
	Horizontal integration
	Horizontal and vertical (spiral) integration
	Integration of basic and clinical sciences
	Integration of courses
	Integration of clerkships
	Integration of organ systems
	Integration of learning modes
	Integration of subjects
	Integration of concepts
	Integration of normal and abnormal
	Integration alone
	Integration other
Second Pass Sub Codes for Organization of Curriculum	Organ systems-based approach
	Full or most organ systems courses
	Discipline approach
	Topic approach
	Phases of the curriculum: 2, 3, 4
	Use term block, unit, or module
	Having a named curriculum
	Other
Second Pass Sub Codes for New Medical Curriculum in Last 10 Years	New medical school
	Only new medical curriculum

During the second pass of the data, it was noted that there were many ways that the websites used the term "integration," whether it was combining it with another term or describing it in different ways. So, a list of sub codes for integration was made, which are found in Table 3.4.

The first pass codes of “systems” and “discipline” were seen to be common in how the courses in the pre-clerkship curriculum were organized. In the second pass of the data, these terms were further categorized into sub-codes for “organization of curriculum” seen in Table 3.4.

The University of Miami example would now have sub codes of “integration of basic and clinical sciences,” “integration of disciplines,” and “integration of normal and abnormal” from the description above. It was also determined to have “integration of organ systems,” “integration of concepts,” and organ systems approach” by looking at other parts of the website. The full coding system and examples of each code may be seen in Table 3.4.

The University of Miami Miller Medical School contained only one campus, and thus had one curricular categorization for it, but other medical schools contain regional campuses. The author doubled-checked the websites of the medical schools to confirm whether the school had regional campuses, whether those campuses had the same or different curricula, or whether those campuses were just for clerkship years. For instance, the Medical College of Georgia has campuses in Augusta, Athens, Albany, Rome, and Savannah, Georgia. The Augusta campus was the primary campus with its own curriculum. Athens was a secondary campus with its own curriculum as well. The other three campuses are only for the clerkship periods of the curriculum (Medical College of Georgia, 2018). For this example, the Medical College of Georgia was considered to be one campus for student population data, but it was considered two distinct campuses with their own curricula. Because of those separate medical curricula, those curricular types were each added in to the final tally of curricular codes and categories for the content analysis of the data.

The next part of this analysis was to create a key for each code which involved using the numbers 1-14 for the "integration" descriptions, the letters A-J for the "organization of the curriculum" descriptions, and the Roman numerals i and ii for the classification of "new medical curriculum in the last 10 years." The author then went through each medical school in Appendix A and documented their curricula by the key. After completing that part, the author tallied how often each code and sub code arose by inputting each number and letter from the medical schools into a spreadsheet.

Analysis of the data included using IBM Statistical Package for the Social Sciences (SPSS) Statistics Version 23 (IBM Corp., 2013) to generate frequencies of each code. This statistical test was run to view a general trend of the data.

Part 2: Survey and Interviews of US Allopathic Medical School Faculty

Another facet of this dissertation research entailed developing and distributing a survey to medical faculty of the anatomical basic science courses (i.e., gross anatomy, microscopic anatomy, and neuroanatomy). This part helped to answer the following research questions:

Research Question 2a: What number of these medical schools (from research question 1) have undergone any major curricular reform within the last 10 years (since 2007), and how does that compare to previous decades?

Research Question 2b. Of the medical schools that have undergone any major curricular reform within the last ten years, what were both the explicit and implicit reasons for reform?

As well as,

Research Question 3: How are anatomical science classes organized within medical school curricula that have been recently revised?

- **a.** Does the overall content coverage increase, decrease or stay the same for classes involving the anatomical sciences?
- **b.** How does the curricular revision change the amount of lab experience and type of lab experience in the anatomical sciences?
- **c.** How does the curricular revision change the lecture experience in the anatomical sciences?
- **d.** What are faculty perceptions of curricular reform at their institution?

The composition, distribution and analysis of the survey instrument will be discussed first, and then the methodology of the interviews will be discussed in this section.

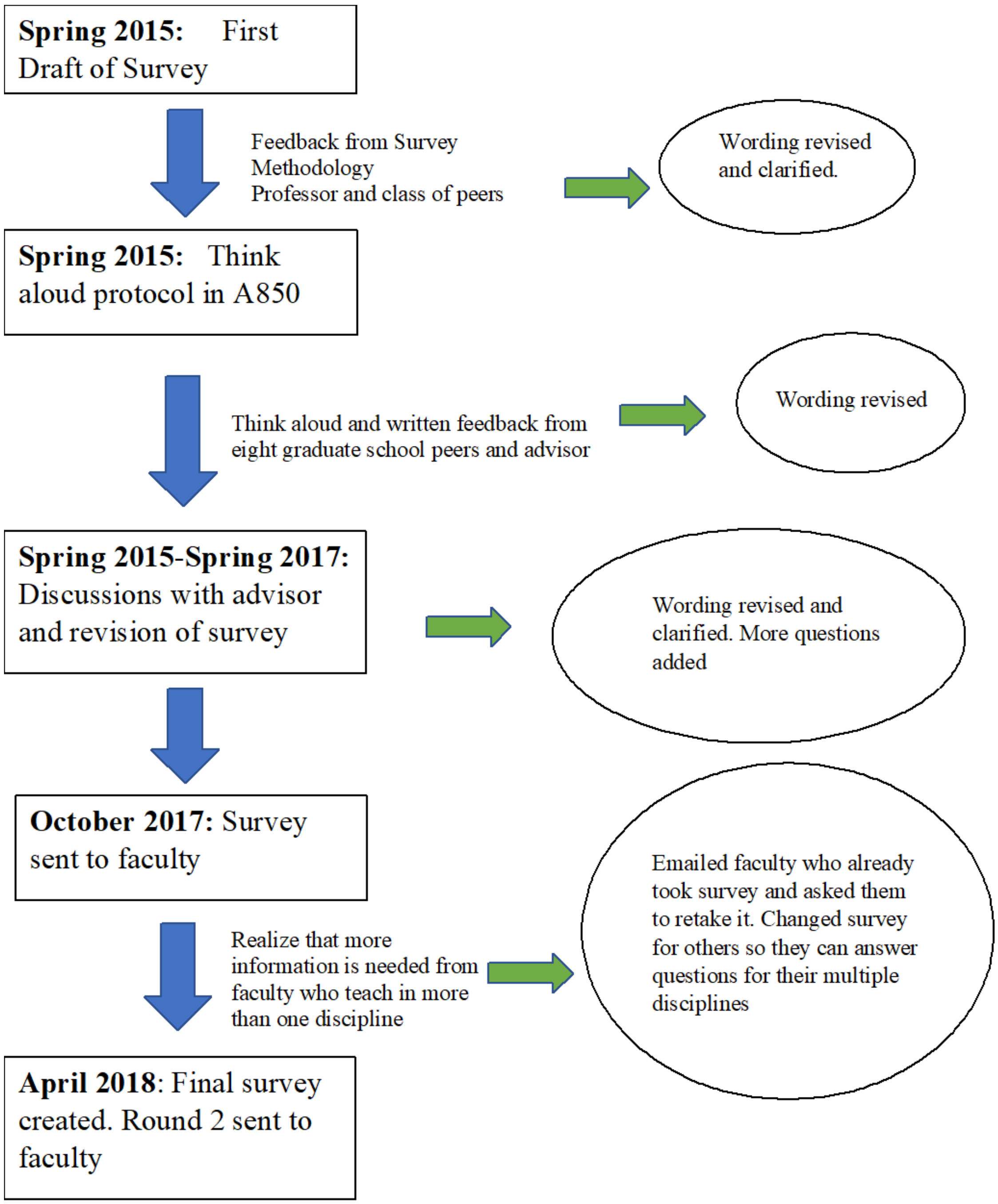
Survey of US Medical School Faculty

This survey was created to obtain more in-depth information about curricular reform at medical schools and how that reform has changed the teaching of the anatomical sciences. This part of the research was completed because many medical schools may be very selective in how they describe their curricula on public websites. They also may not necessarily explain *why* this curricular reform happened. These are very important questions that were asked of the faculty members in the survey. Additionally, interviews with faculty were conducted to gain a broader sense of their perceptions of curricular reform at their medical institutions. Below is an overview of the methods used for this part of the research.

Composition and Revisions

The survey, seen in Appendix B, was developed, revised and underwent steps towards validation through the following iterative process that is displayed in Figure 3.1 and utilized similar steps for survey validation from Gideon (2012). The first draft of the survey was developed by the author in spring 2015, as a required assignment in a graduate *Survey Research Methodology* course taken at Indiana University. The author chose to develop a survey for the course that she could use for her dissertation. The *Survey Research Methodology* professor, as well as many of the author's peers (approximately 20), read through the survey questions and gave feedback on how to reorganize and reword the questions. Additional feedback was received during a PhD anatomy journal club (Anatomy A850 class) session from 8 of the author's peers (anatomy graduate students) as well as two IUSM-B anatomy professors. Other additional feedback from the author's advisor provided iterative feedback on the survey from spring of 2015 to spring of 2017. The author and her advisor met approximately once a month to go over the questions on the survey. Both written and think-aloud feedback were received during this session.

Figure 3.1: Validation of Faculty Survey Instrument



This survey initially was distributed to faculty in October of 2017. However, revisions to the survey had to be made because the author noticed that many respondents would check multiple boxes for their role at the institution, but only were able to answer questions related to one of their roles (e.g., they were a faculty member who taught both gross and microscopic anatomy, but the survey only allowed them to fill out responses for the gross anatomy course). The author attempted to rectify this by emailing the respondents who provided their contact information and who also had more than one teaching role at their medical school and asked them to fill out the rest of the survey for that other role. A new iteration of the survey was created through SurveyMonkey (SurveyMonkey, Inc., 2017) with a slight amendment of allowing the respondent to not only choose more than one role at their institution but also to be able to answer questions related to all their roles. This new survey iteration was distributed via a new link beginning in April 2018 and remained open until August 2018. For faculty who responded to both the old and new iteration of the survey, their data from the new iteration was used. If the faculty only responded to the old iteration but had multiple roles at their institutions, the data was still used, but was noted as a possible limitation of the study.

Questions from the faculty survey included both quantitative and qualitative, open ended questions. Some of the questions that were asked on the survey included the following:

- <u>Questions about the general curriculum at the medical school</u>, including whether the medical school had undergone curricular reform in the last 10 years, what were the main reasons for reform, if the faculty member had an involvement with the planning of the curricular reform, and how specifically the curriculum was changed due to the reform. Additionally, the faculty member answered what anatomical discipline courses they taught in. There are 12 of these questions with a mixture of quantitative (8) and qualitative open-ended questions (4).

- Questions pertaining to the three anatomical disciplines, such as how they are organized within the curriculum, what is included in the lab component, and how the number of hours and topics were changed due to curricular reform. The number of questions that the respondent would answer varied depending on what they put as the anatomical science discipline they taught. For instance, if they taught gross anatomy and microscopic anatomy, they would answer the same questions for each of those disciplines. There were 11 of these questions per discipline and contained a mixture of quantitative (9) and qualitative open-ended questions (2).
- Questions about perceptions of the curriculum, including five Likert scale items, where faculty could respond to a statement with strongly disagree, disagree, neutral, agree, or strongly agree. An example of a statement is "I am enjoying teaching within our school's curriculum." There was also one question on a 1-10 scale asking about overall satisfaction with curriculum, with 1 = not at all pleased, 10 = extremely pleased.
- Open-ended questions about what faculty members like and dislike about the curriculum and any constructive suggestions they have to improve to curriculum. There were 3 of these questions.

Recruitment and Distribution

Sampling of participants included a mix of two sampling methods: purposeful non-probability expert sampling and convenience sampling. **Purposeful sampling** is a deliberate non-probability sampling of participants due to the qualities that they possess

(Etikan et al., 2016). The author already had the target population of medical anatomical science faculty in mind. **Expert sampling** means that the target population would be knowledgeable about the phenomena that is occurring (O'Leary, 2005), in this case that is faculty members who teach in the anatomies at an allopathic medical school in the United States and who are privy to the curricfular reform occurring at their institution. Expert sampling is a common sampling method for mixed methods research (Palinkas et al., 2015). Recruitment for this survey included posting a description and link to the survey on different professional societies' listservs, including: American Association of Anatomists (AAA), Human Anatomy and Physiology (HAPS), American Association of Clinical Anatomists (AACA), DR-ED (an electronic discussion group for medical educators sponsored by The Office of Medical Education Research and Development at the Michigan State University College of Human Medicine), and the Association of Anatomy, Cell Biology and Neurobiology Chairpersons (AACBNC). Other recruitment methods included advertising the survey through my attendance at the AAA and HAPS Conferences that occurred in the spring of 2018.

In addition to the above strategies, the author also contacted several anatomy faculty through convenience sampling. **Convenience sampling** is also a non-probability sampling method where members of the target population who meet certain criteria, such as personal and professional contacts, or those who are geographically close to the researcher, are sampled. More specifically, recruitment for this survey included emailing faculty members known by the author, such as faculty at IUSM-B and faculty members that have graduated from Indiana University's Anatomy Education PhD program and who now teach at other schools. The author also emailed anatomy faculty who were members of AAA and provided their contact information in the membership directory.

The survey was in an online format through SurveyMonkey (SurveyMonkey Inc., 2017) and was open from October of 2017 until August of 2018.

It is hard to gauge exactly how many medical anatomical science faculty are employed at each medical school. It can be estimated that there are, on average, three anatomical science faculty per school (one for each gross anatomy, microscopic anatomy, and neuroanatomy courses), but that is probably not an exact number. Some medical institutions, especially larger ones that may contain multiple regional campuses, may have multiple instructors who teach in the anatomical disciplines. For instance, at IUSM, there are nine regional campuses for the medical school, and so there are many more than three total instructors who teach in the anatomical disciplines. Since there are 145 allopathic medical schools in the United States, multiplied by three, that would mean there are, at minimum, 435 medical anatomical science educators in the United States. Obviously, the numbers will vary from medical school to medical school, with some larger medical schools having multiple faculty teach one discipline. That said, there was not a projected sample size chosen on where to end the data collection. For purposeful sampling, as described above, data collection is completed when data saturation is reached. **Data saturation** occurs when the participants can no longer contribute any additional perspectives to the research, and so the appropriate sample size has been reached (Ando et al., 2014).

Quantitative Analysis of Faculty Survey

Data analysis of the survey commenced in August 2018, and survey data were compiled into a spreadsheet (Excel, 2016) and then analyzed using IBM Statistical Package for the Social Sciences (SPSS) Statistics Version 23 (IBM Corp., 2013). This quantitative data was analyzed by using descriptive statistics and frequencies to identify a general trend of the data. Additionally, other statistical measures were performed to see if certain variables related with on another. Before these statistical measures were performed, however, the author performed tests of normal distributions on the data, including looking at a skewness and kurtosis of the data. Skewness is a measure of the asymmetry of the data, and kurtosis is a measure of the degree to which data cluster at the ends of the distribution (Field, 2013). After running these tests with the data in SPSS, it was found that most of the variables are contain a degree of skewness and kurtosis outside of the normal (please see Field, 2013 about what normal values are for skewness and kurtosis) and thus non-parametric tests were performed on the data. Additionally, because there were multiple statistical tests run on the perception variables, a Bonferroni correction had to be conducted for each test. This is where the level of significance is adjusted for individual statistical tests so that the overall Type I error rate (rejection of the null hypothesis, or a false positive finding) across all comparisons remains at 0.05. This correction takes account of the total number of statistical tests conducted and divides the 0.05 by those tests to get a new significance (p) value (Field, 2013). The author will explain the new significance values used for the data in Chapter 5.

A correlation matrix, using Spearman's correlation coefficient (denoted as r_s), was conducted to explore the survey responses which related most with each other for the interval data. Spearman's correlation is a non-parametric test similar to the parametric test of Pearson's r correlation. Interval data are continuous data which have equal intervals on a scale which represent equal differences in the variables (Fields, 2013). Interval data from the faculty survey included comparing the perceptions of faculty on a 1-10 scale versus the extent to which faculty were involved in the planning of the curriculum (1-5 scale). Additionally, faculty perceptions on the 1-10 scale were compared with the extent to which the anatomical science courses (lecture and lab) had changed due to curricular reform (1-5 scale). These variables are considered interval data because when the faculty took the survey, they were able to view how, for example, a response saying that gross anatomy lecture changed "to a large extent" due to curricular reform equated to a 5 on the 1-5 scale. During the analysis process using SPSS (IBM Corp., 2013), it was those numbers (1-5) that were exported into the document, rather than the string variables chosen (to a small extent, to a large extent, etc.) Correlation coefficients are considered effect sizes (Fields, 2013), and the strength of the correlations was interpreted based on recommendations by Mukaka (2012). These recommendations are seen in Table 3.5.

Table 3.5: Correlation Interpretations

Direction of Correlation	Size of Correlation (r_s)	Correlation Strength
Positive – variables are directly related (i.e., as the value of one variable goes up, the value of the other goes up)	0.90 – 1.00	Very strong positive
	0.70 – 0.90	Strong positive
	0.50 – 0.70	Moderate positive
	0.30 – 0.50	Weak positive
No correlation	0.00 – 0.30	Very weak
Negative – variables are inversely related (i.e., as the value of one variable goes up, the value of the other goes down)	-0.30 – -0.50	Weak negative
	-0.50 – -0.70	Moderate negative
	-0.70 – -0 .90	Strong negative
	-0.90 – -1.00	Very strong negative

From Mukaka, 2012

Additional statistical tests were performed to discover possible relationships among other data from the survey. In order to discover relationships among categorical (nominal) and ordinal variables, a Chi square test of independence (also referred to as Pearson chi square test) was performed. Categorical variables include those which are classified into categories. For example, from the faculty survey, in the question "Has you medical school undergone any major curricular reform in the last 10 years?" the responses to this question are either "yes" or "no." Those two responses are the categorical variables. Ordinal variables are categorical variables that are ordered in a certain way, but there is no set distance between the ordered variables, unlike interval data (Fields, 2013). In this survey the Likert scale perception variables (strongly disagree, agree, etc.) were considered ordinal data as opposed to interval data because the faculty respondents were not able to view what each answer choice equaled on a 1-5 scale, unlike the variables mentioned above which were used in the correlation analysis.

The following statements served as the Likert scale perception variables in this survey:

- I am enjoying teaching within our school's curriculum.
- I feel my students are getting adequate knowledge of Gross Anatomy in our school's curriculum.
- I feel my students are getting adequate knowledge of Microscopic Anatomy in our school's curriculum.
- I feel my students are getting adequate knowledge of Neuroanatomy in our school's curriculum.
- I feel like this medical program is producing adequately-trained medical doctors.

The following survey variables were compared with the Likert scale perception variables:

- Answering yes vs no on "Has your medical school undergone curricular reform in the last 10 years?"
- Amount of time since curricular reform was implemented
- Answering yes vs no on "Did you actively participate in the initial development process of the curricular reform?"
- How the anatomies are taught (stand-alone, combined with another discipline, part of a systems-based curriculum, other)
- How the amount of time in the anatomies changed (increased, decreased, stayed the same)
- How the number of topics in the anatomies changed (increased, decreased, stayed the same)

In order to discover differences in the faculty perceptions of the medical curriculum (the Likert scale perception variables from above) in those faculty whose medical school had undergone curricular reform versus those whose medical school had not undergone curricular reform, a Mann-Whitney U test was performed. This statistical test measures and compares the mean ranks of two groups, and it is a non-parametric test (Fields, 2013). The Mann-Whitney U test also compared the faculty perceptions from the Likert variables with faculty answering "yes" or "no" about participating in the initial development process of the curricular reform.

A Kruskal-Wallis statistical test measures the medians of more than two independent groups, and, like the Mann-Whitney test, it is a non-parametric test. For this survey data, the Kruskal-Wallis test compared the medians of how the anatomical sciences were taught (stand-alone, combined with another discipline, systems-based, other) with Likert scale faculty perceptions data. For example, the author wanted to see if faculty enjoyed teaching in their medical curriculum more when the gross anatomy course was taught as a stand-alone course versus part of a systems-based course.

Qualitative Data Analysis of Faculty Survey

For the qualitative analysis of the open-ended survey questions, MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used with content analysis of the qualitative data which is discussed above in the *General Methodology* section. This software is designed for use in quantitative, qualitative, and mixed methods research. It has the ability to organize, categorize, retrieve information, and create reports. This analysis of the open-ended questions used a deductive followed by an inductive approach. A list of a priori codes was generated from previous medical curricular reform research references in Chapter 2 under the *Medical Education Reform and the Anatomical Sciences* section. Following the complete analysis of the open-ended questions from the faculty surveys, a list of refined sub codes and codes was created. The codebook for the data may be seen in Appendix G. The analysis of the open-ended questions on the faculty survey are presented in Chapter 5.

Interviews of US Medical School Faculty

The goal of the medical school faculty interviews was to follow-up from the surveys and provide a richer, more in-depth look at trends seen from the survey data. Additionally, the author desired to gain insight into faculty perceptions and opinions on curricular reform at their medical schools that may not have come across fully in the survey responses.

Once US medical school faculty completed the survey, they had the option to write in their contact information and agree to be included in a follow-up phone interview. The author sent the faculty members who agreed to a follow-up interview an email asking if they were still interested in completing the interview and what days and times would work. The author sent emails to approximately five people at a time in order to appropriately space the interview scheduling. Once those five people had either not answered the email, declined the interview, or completed the interview, the author sent out emails to another five individuals. These interviews began in January 2018 and continued until July 2018.

For the interviews, a convenience sampling method was used. As a reminder, convenience sampling is where members of the target population meet certain criteria (Etikan et al., 2016). Faculty had the option to write in their contact information on the faculty survey if they wished to be contacted by the author for an interviews. Thus, the convenience sample criteria used was anatomical science faculty who had completed the survey and written their contact information on the survey. Convenience sampling also allows for generalizability so that data can be representative of the population (Etikan et al., 2016), in this case, those faculty who answered the survey questions.

These interviews were semi-structured in that the author had a set list of questions to ask each interviewee, but at times the author would allow the conversation to deviate from some of the topics and explore topics that were not on the interview sheet. A list of interview questions may be found in Appendix C. Some of those questions included asking what led to the need for curricular reform at their institution, how the course the faculty member teaches in changed due to curricular reform, how their students are doing now as a result of curricular reform, and what they think the point of curricular reform is. The interviews were conducted by telephone and were recorded using a digital recording device.

Transcription of the data was completed with help of the Dragon NaturallySpeaking Software, Version 15 (Nuance Communications, 2018). This type of software allows for the import of audio files and conversion into text files, thereby eliminating the task of written transcription of the data. The author reviewed the data to check for accuracy of transcription and to fix any errors (punctuation or otherwise) that the program did not fix. However, upon using this software, it was found that the software did not give accurate transcriptions of the audio recordings of the participants. The author trained the software to her voice, so the software was able to provide transcriptions of only her part in the interviews, but not of the participants. The author then went through each of the audio recordings and transcribed the parts that had not been fully transcribed by the Dragon software system. This way, the author was still able to fully immerse herself in the data through transcription of it, rather than having a software system complete all the transcriptions.

MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used with this interview data. A thematic analysis approach was used to analyze the data. More specific information on the thematic analysis can be seen under the *General Methodology* section. The analysis of the data generally used a deductive followed by an inductive approach. The codebook for the interview data may be seen in Appendix H.

This part of the research was granted exempt status by the Indiana University Bloomington Institutional Review Board (#1610692944) on the basis of voluntary participation, anonymity, and minimal risk to participants. Detailed information regarding the purpose and procedures for the study were distributed to faculty through a study information sheet that they could access before taking the survey.

Part 3: Case Study at the Indiana University School of Medicine-Bloomington (IUSM-B) Campus

A case study of curricular reform at Indiana University School of Medicine-Bloomington (IUSM-B) was conducted in order to examine in detail the effects of medical curricular reform at a single institutional location. It is at this institution that the author is a graduate student, so there was easy access to both faculty and students as well as general first-hand knowledge about the pre-clerkship curriculum. First-year medical students were surveyed, and a sample were included in a focus group to elaborate on their survey answers. In addition, a focus group of anatomical science faculty at IUSM-B provided data for this case study. This part of the research helped answer the following research questions:

Research Question 3: What are student and faculty perceptions of curricular reform at a case study institution (Indiana University School of Medicine-Bloomington), and how to they compare to the US landscape?

- **a.** How do first-year students at IUSM-B perceive the newly implemented medical curriculum that began in Fall of 2016?
- **b.** How do faculty perceptions of curricular reform at IUSM-B compare to faculty perceptions from other US medical schools?

Over the course of this research, the author gathered information from IUSM-B about the curricular reform that occurred at the institution, including the following sources of data:

- Curricular information from the IUSM website,
- A 62-page document from the IUSM Statewide Anatomy Retreat, which occurs every year with anatomy faculty from all campuses of IUSM, and
- Syllabi from the anatomical science courses taught in the new curriculum.

This information will be presented in the results of Chapter 6.

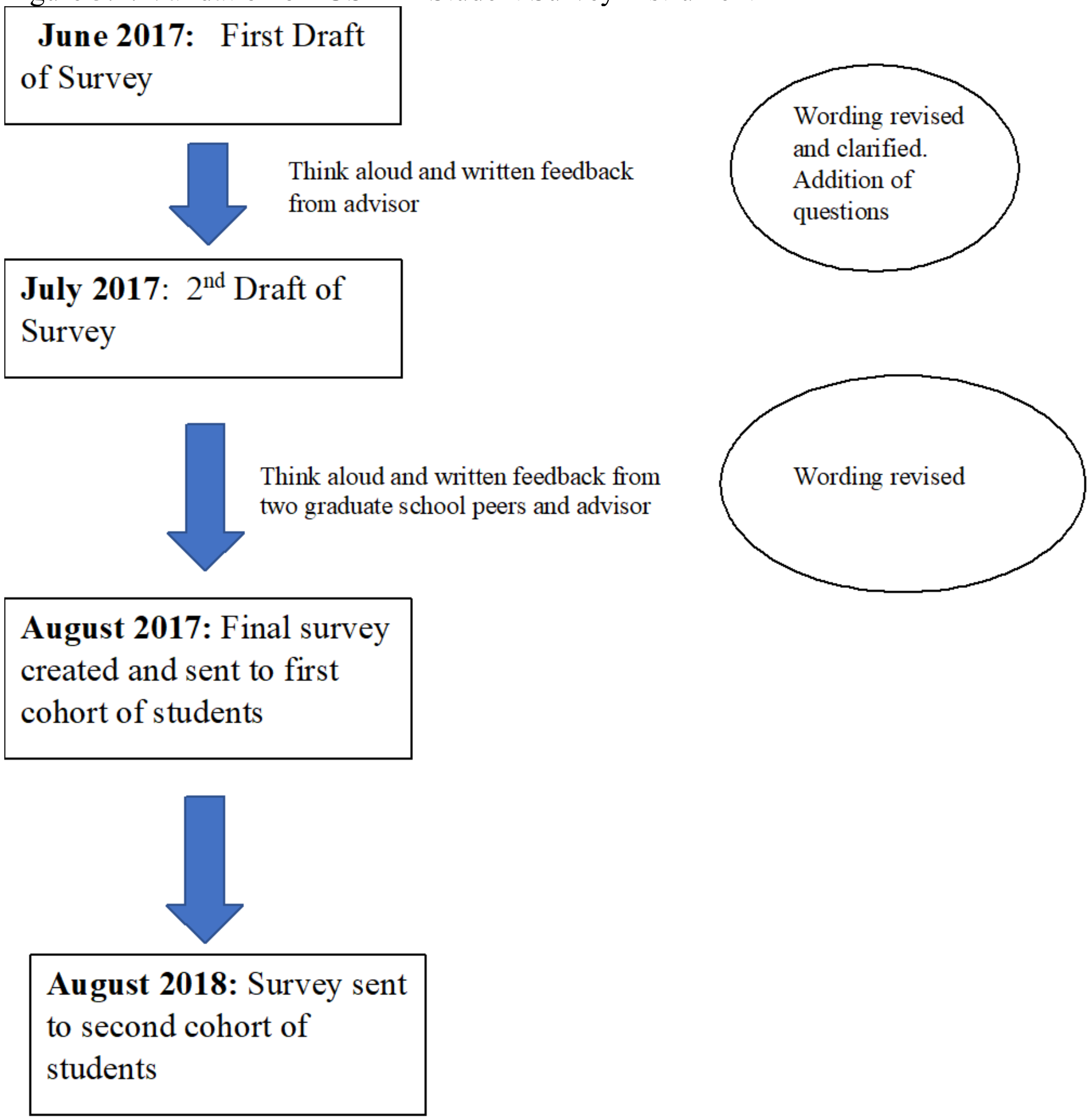
IUSM-B Student Survey

Composition

Students who had completed the first-year of the pre-clerkship curriculum at IUSM-B were invited to partake in a survey that was distributed in the summer of 2017 and the summer of 2018. The invitation was sent to students after they had finished their first year of medical school, and before they began their second year. Only first-year students from IUSM-B were chosen to partake in the survey since the anatomical basic science courses are taught in the first year of the medical program at that school. IUSM contains nine campuses including Bloomington, Indianapolis, Fort Wayne, Muncie, Evansville, Northwest (Gary), Terre Haute, South Bend, and West Lafayette. Focusing on only IUSM-B students (as opposed to all IUSM students from all 9 campuses) was done to minimize external variation such as different instructors and style of teaching across the different campuses.

The survey, seen in Appendix D, was developed, revised and underwent steps towards validation through the following iterative process shown in Figure 3.2 and utilizes similar steps for survey validation by Gideon (2012). The author developed a survey tool for first-year medical students in June 2017. After the initial draft was completed, the author sent the survey to her advisor where extra questions were added, and wording was clarified. After that initial feedback, the author sent it to two of her graduate school peers. Both written and think-aloud feedback was given by each peer, and the survey was revised with that feedback in July 2017. As the survey was to be distributed very soon after the initial development of it, no additional feedback or validation was able to occur. The author sent the survey to the students in August 2017, after they had come completed their first year of medical school and come back from summer vacation. The students completed their gross anatomy and microscopic anatomy course (called Human Structure) that previous fall (fall 2016), but they did not take their neuroanatomy course (called Neuroscience and Behavior) until spring of 2017. Once that course ended, the medical students took their NBME final examination for Neuroscience and Behavior, and then most students left school for their summer vacation. It was decided by the author to distribute the surveys to the students immediately after they returned from their summer break in order to increase the response rate. Data was also collected from a second cohort of medical students in August 2018.

Figure 3.2: Validation of IUSM-B Student Survey Instrument



Questions from the student survey included both quantitative and qualitative, open ended questions. Some of the questions that were asked on the survey included the following:

- <u>Likert scale questions</u> (1-5 scale 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree) about satisfaction of time dedicated to teaching the three anatomical disciplines, if they felt rushed learning the material, how they liked the integration of gross and microscopic anatomy, and if they felt the curriculum prepared them for the NBME exams. These 6 questions were mostly quantitative, aside from the qualitative questions asking them to explain their responses to the Likert questions.

- One question on a 1-10 scale (1 = not at all pleased and 10 = extremely pleased) about their overall perceptions of the curriculum.
- Open-ended questions about what they like and dislike about the curriculum and any constructive suggestions they have to improve to curriculum. There were 3 of these questions.

Specific questions can be seen in Appendix D. The online survey was developed on SurveyMonkey (SurveyMonkey Inc., 2017). IUSM-B medical students were invited to participate in the survey and given a link to the survey via an email sent out by the Medical Sciences office manager to the student emails.

Recruitment and Distribution

Data from the first cohort of IUSM-B medical students was collected in August of 2017. Data from the second cohort was collected in August of 2018.

The number of medical students at the IUSM-B is an exact known, as opposed to the estimated number of anatomical science faculty at the US medical schools. The population size of one cohort of first-year medical students at this campus is 36. The population size did not change from the first to the second cohort, so the total population size was 72 students. Since the entire population of first-year medical students at IUSM-B were surveyed, the type of sampling method employed was **purposeful total population sampling**, or TPS (Etikan et al., 2016). This type of sampling is where the entire population that meet a certain criterion (e.g., first-year medical students at IUSM-B) are included in the research.

Quantitative and Qualitative Survey Analysis

At the completion of the end of the data collection period in September 2018, survey data were compiled into a spreadsheet (Excel, 2016) and then analyzed using IBM Statistical Package for the Social Sciences (SPSS) Statistics Version 23 (IBM Corp., 2013). Specific information on the quantitative statistical tests that were run can be seen under the *General Methodology* section.

For the qualitative analysis of the open-ended survey questions, MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used with the data. Similar to the faculty survey data discussed above, content analysis of the qualitative data was used. The methods of this approach are discussed in the *General Methodology* section. This analysis used a deductive followed by an inductive approach. A list of a priori codes was generated from previous medical curricular reform research as referenced in Chapter 2 under the *Medical Education Reform and the Anatomical Sciences* section. Following the complete analysis of the open-ended questions from the student surveys, a list of refined codes and categories was created. The codebook for the data may be seen in Appendix I.

IUSM-B Student Focus Group

Students from IUSM-B also had the option to participate in a focus group session after they completed their first year. Any medical student from IUSM-B who had completed their first year had the ability to attend this focus group session, regardless of whether or not they had completed the survey. This focus group asked similar questions as the survey, so it did allow for a more in-depth look at trends from the survey data.

Only one cohort of medical students, those who matriculated in fall 2016, was chosen for the focus group. Due to time constraints, the author did not collect data from the second cohort.

Focus group data was collected in August of 2017. The August collection date, which happened to coincide with when the students entered their second year of medical school, was chosen because students do not take their Neuroscience and Behavior NBME exam until almost the last day of the spring semester. Many students would then leave campus for the summer, not arriving back until August. In order to have an adequate number of students partake in the focus group, it was decided to conduct it when they all returned to campus after the summer. Thus, the type of sampling method employed was convenience sampling, which is discussed above with the faculty interviews.

The students were contacted through email by the author with information about the focus group. It took place over the lunch period for the students. Lunch was provided for the students, though that did not require them to stay for the focus group. The author distributed name tags with numbers written on them, and that served as the only identifying feature, so that the author could keep track in her notes about who was saying what.

A list of questions that were asked of the participants in the focus group is in Appendix E. This focus group used a semi-structured interview approach, by which the author had a set list of questions to ask the group, but at times the author would allow the conversation to deviate from some of the topics and explore topics that were not on the interview sheet. The general questions included inquiring about what the students were told about the new curriculum, how they felt about the amount of time dedicated to the anatomical sciences in their courses, and the extent to which they believe the courses and instructors prepared them for their examinations. The session was recorded using a digital recording device, and the author took notes on the important aspects of the conversation, utilizing the numbers on the participants' name tags for identification.

This focus group was guided by steps outlined by Krueger and Casey (2002) which included setting the focus group participants up in a quiet environment, discussing what the purpose of this session entailed, pausing to wait for answers and probing the participants to expand on their answers, and taking notes on the discussions. The session lasted about one hour and was audio recorded to ensure the accuracy of statements.

Transcription of the data was completed with help of Dragon NaturallySpeaking Software, Version 15 (Nuance Communications, 2018). Again, there was the issue with the software not fully transcribing the data from the audio recordings, so the author had to transcribe it herself.

For the analysis of these data, MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used. More specific information on the thematic analysis can be seen under the *General Methodology* section. The analysis of the data used both a deductive and inductive analytical approach. Attempts to document any biases were done through the generation of memos during analysis to help account for any subjectivity. This codebook for the data can be seen in Appendix J.

IUSM-B Anatomical Science Faculty Focus Group

A semi-structured interview with faculty who teach in the anatomical sciences at IUSM-B was conducted in August of 2017. There are currently 4 main instructors that cover the anatomy topics of gross anatomy, embryology, histology, and neuroscience in the IUSM-B pre-clerkship curriculum. This focus group consisted of inviting those faculty to a discussion of the curriculum after a normal meeting where they were all already present.

A list of questions that were asked of the focus group may be seen in Appendix F. The general questions that were asked included inquiring about what led to the need for curricular reform at IUSM-B, gaining insight on how faculty perceived working with others in the courses they taught as well as with faculty from different campuses, and asking how well the faculty believed the students were doing as a result of the curricular reform.

The focus group was guided by steps outlined by Krueger and Casey (2002), described above under the *Student Focus Group* section.

Transcription of the data was completed with help of Dragon NaturallySpeaking Software, Version 15 (Nuance Communications, 2018), though, as stated above, the author had to transcribe the data herself.

For the analysis of the data, MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used. A thematic analysis approach, similar to the faculty interview analysis, was conducted. The codebook for this data set may be seen in Appendix K. The codes and themes that emerged from the analysis of the IUSM-B anatomical science faculty focus group data were compared to codes and themes from the interviews of other faculty from the interviews discussed in Part 2 of this study. Any differences in codes and themes from the IUSM-B faculty are made note of and presented and discussed in the following chapters.

The case study part of the research (both the IUSM-B med student and faculty components) was granted exempt status by the Indiana University Bloomington Institutional Review Board (#1611113501) based on voluntary participation, anonymity, and minimal risk to participants. Detailed information regarding the purpose and procedures for the study were distributed to the students through a study information sheet that they could access before taking the survey as well as a written informed consent that they signed before the focus group. A separate informed consent was distributed and signed by the faculty involved in their own focus group.

Summary

The methodology discussed in this chapter helped to answer research questions which explored how medical institutions classify their curricula, how faculty perceive the curricula at their medical schools, and how the Indiana University School of Medicine-Bloomington campus organized its own curriculum as well as how students and faculty there perceive it.

This research utilized a mixed methods approach with the use of quantitative data from surveys distributed to faculty members who taught in the anatomical sciences at their medical school and first-year medical students from IUSM-B. Qualitative data was collected from a website analysis of the allopathic medical schools in the United States, open-ended questions on the surveys, as well as interviews and focus groups of the faculty and students.

The next chapters discuss the findings and analysis of the above-mentioned research. The results are presented in three different chapters. Details for this are displayed in Table 3.6. Chapter Four covers the findings and analyses from the website analysis of the allopathic medical schools in the United States. Chapter Five discusses the results from the faculty surveys and interviews. The quantitative survey questions are divided by category into major curricular reform, organization of the anatomies, changes in the anatomies, and Likert-scale and perception questions. Finally, Chapter Six presents the results from the case study at IUSM-B. In this chapter, an overview of the curriculum at IUSM-B is discussed, and the results from the student surveys and student and faculty focus groups are displayed. The quantitative questions from the student surveys are divided by category into Likert scale items of the anatomical sciences and perceptions of the overall curriculum.

Table 3.6: Overview of Methods and Where Results May be Found in this Dissertation

Type of Data	Population Studied				Type of Analysis
	US Medical Schools	US Medical School Faculty	IUSM-B First-year Medical Students	IUSM-B Anatomical Science Faculty	
Chapter	4	5	6	6	
Quant.					
Survey	N/A	Major Curricular Reform Org. of Anatomies Changes in Anatomies Likert Scale items and perceptions	Likert Scale items about anatomies Perceptions of overall curriculum	N/A	Descriptive statistics Chi square test of indep. Spearman correlation Mann-Whitney U Kruskal-Wallis test

Qual.					
Website Analysis	Coding	N/A	N/A	N/A	Content analysis
Survey	N/A	Open-ended questions	Open-ended questions	N/A	Content analysis
Interview/ Focus Group	N/A	Transcription	Transcription	Transcription	Thematic analysis

CHAPTER 4: RESEARCH AND ANALYSIS OF CURRICULA AT ALLOPATHIC MEDICAL SCHOOLS IN THE UNITED STATES

Previous chapters have described how there is no one definition for integration or curricular reform, especially pertaining to medical school curricula. While some medical schools may organize their curricula around basic science disciplines, or be considered a "traditional curriculum," other medical schools may organize their curricula around organ systems (Cooke et al., 2010). Other institutions may follow a completely different type of curricular model, such as problem-based (Barrows and Tamblyn, 1980) or clinical presentation based (Woloschuk et al., 2004).

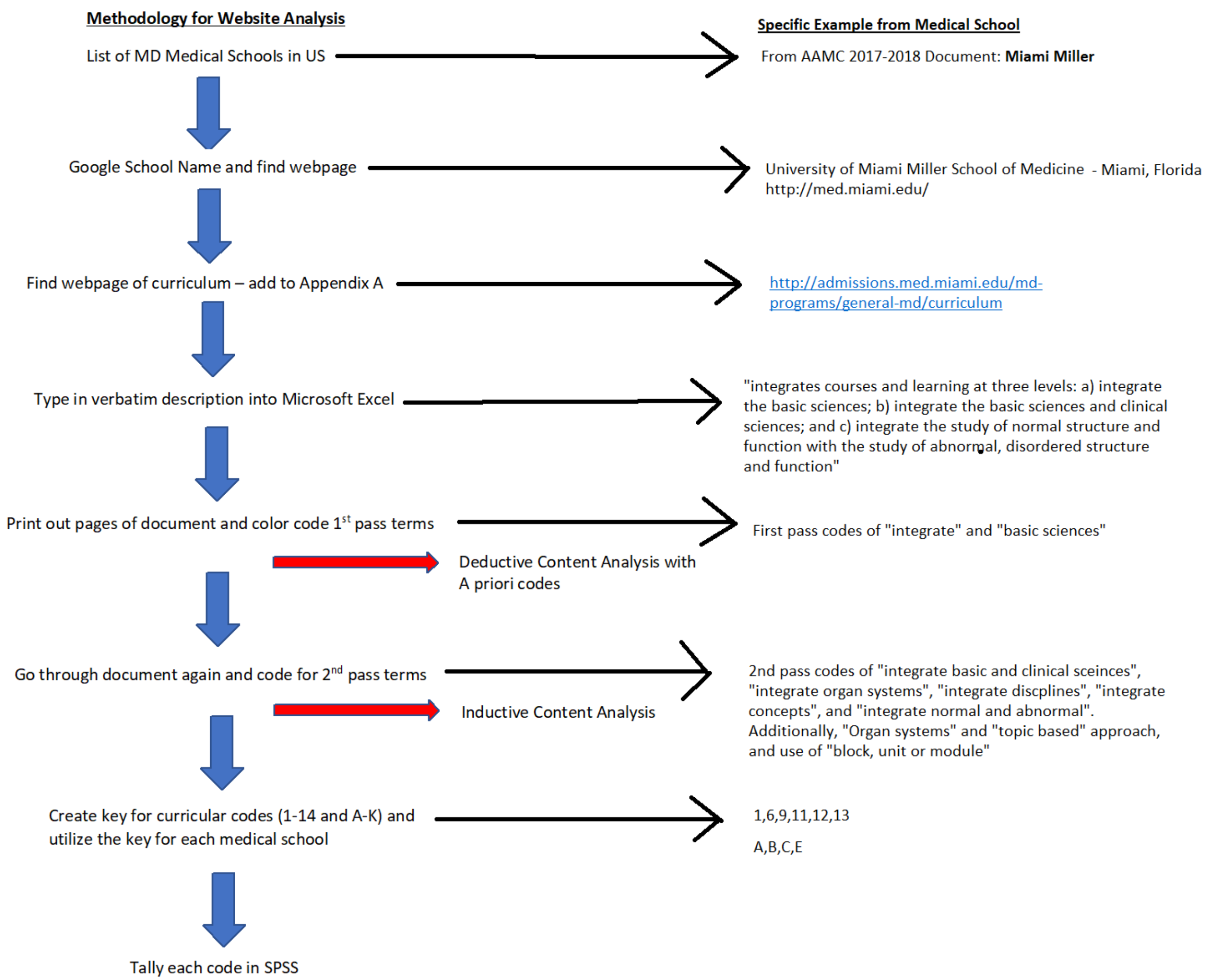
Medical institutions may also integrate their curricula, but the term integration may have many different meanings, and there are various types of integration a curriculum may adopt. Medical schools may have horizontal integration, where subjects or concepts are integrated during the year (Halliday et al., 2015), or they may have vertical integration, which is integration of subjects or concepts throughout the years of the medical program (Lazarus et al., 2014). Additionally, medical schools may have a combination of horizontal and vertical integration, where integration occurs at all stages and phases of the curriculum (Brauer and Ferguson, 2015). Thus, there is no "one size fits all" approach to medical education. Medical schools have many different ways of organizing their curricula, and this chapter chronicles the various ways allopathic medical schools in the United States have organized their curricula. This chapter addresses the following research question (see Chapter 3 for a discussion of the research chapter hypothesis and rationale):

Research Question 1: How do American medical schools granting a medical doctorate degree classify their curricula (e.g., horizontal, vertical, or spiral integration, problem-based learning curriculum, basic science integration, organ-systems based, etc.)?

Methodology

This phase of the dissertation research was designed to collect descriptions of the website curriculum at each allopathic medical school in the United States. Through analysis of these varied descriptions, the author sought to create a new comprehensive curricular schema that would assist with medical schools designing and classifying their curricula. No study before has conducted as extensive a study on classification of curricula since Papa and Harasym (1999). The specifics on the methods for the website analysis and classification of medical curricula were presented in Chapter 3, and they are briefly reviewed here. Additionally, one medical school (The University of Miami Leonard M. Miller School of Medicine) serves as an example for the methodology used. The methodology steps are outlined in Figure 4.1.

Figure 4.1: Methodology used and Example from a Medical School



The first step of the website analysis was visiting the Association of American Medical Colleges (AAMC) website on student enrollment (Association of American Medical Colleges, 2017) and viewing the names of the medical schools listed. An alphabetical list of these schools was created in Microsoft Excel (2016). The University of Miami Miller School of Medicine was listed as "Miami Miller."

The next step involved using the Google search engine tool to find the web page of each medical school. The author used the Google search engine and typed in "Miami Miller medical school." The webpage that came up was http://med.miami.edu/. Additionally, location (city and state) of the main campus and of regional campuses (if applicable) were also found on the website and added to the Excel spreadsheet. The campus of Miami Miller School of Medicine was located in Miami, Florida, and there were no regional campuses. The author then found the websites from each school that displayed information about the medical curriculum, and that webpage served as the one that was placed in Appendix A. For Miami Miller, the curricular webpage was http://admissions.med.miami.edu/md-programs/general-md/curriculum.

Next, the author went to the webpage where the curriculum of the school was located and wrote a brief, verbatim description of the curriculum in Microsoft Excel. The description for Miami Miller was the following:

> "…integrates courses and learning at three levels: a) integrate the basic sciences; b) integrate the basic sciences and clinical sciences; and c) integrate the study of normal structure and function with the study of abnormal, disordered structure and function."

With this description, the author conducted content analysis with the data (Bengtsson, 2016). First a deductive approach was used, referred to as the "first pass" of the data, whereby a priori codes were generated from the literature search on this topic.

Please see Chapter 2 under the *Medical Education Reform and the Anatomical Sciences* section. Coding for the first pass of each website curricular description included printing out the spreadsheet of the medical schools and their curricular descriptions and then highlighting each of the codes with a different color of pen or marker. This procedure helped keep a visual track of all the different coding variables. The first pass coding of the Miami Miller data included the codes of "integrate" and "basic sciences."

After the first pass of each website, the curricular descriptions of each medical school were reviewed again using the same process of highlighting with a pen or marker, and then a larger list of codes and sub codes was developed using inductive content analysis, referred to as the "second pass" of the data. During the subsequent passes of the data, the author began on different schools, rather than going straight through them alphabetically. After going through the data from the different medical schools, a newer, more refined list of codes was generated, which was considered the second pass of the data. The second pass coding of Miami Miller curricular descriptions included the following sub codes: "integrate basic and clinical sciences," "integrate organ systems," "integrate disciplines," "integrate concepts," and "integrate normal and abnormal." Additionally, "organ systems" and "topic-based courses" and use of "block, unit or module" were found from other areas of the curricular description.

The next part of this analysis was to create a key for each code which involved using the numbers 1-14 for the "integration" descriptions, the letters A-J for the "organization of the curriculum" descriptions, and the Roman numerals i and ii for the classification of "new medical curriculum in the last 10 years." The author then went through each medical school in Appendix A and documented its curriculum according to the key. For Miami Miller, the numbers 1,6,9,11,12, and 13 were used for the "integration" sub codes, and the letters A,B,C, and E were used for the "organization of the curriculum" sub codes.

After documenting the curriculum by the key for each medical school, the author tallied how often each code and sub code arose by inputting each number and letter from the medical schools into a spreadsheet and analyzing the frequencies and converting into percentages through use of IBM Statistical Package for the Social Sciences (SPSS) Statistics Version 23 (IBM Corp., 2013).

Results

The results of the website analysis are split into two parts. The first part presents US medical school demographics, while the 2^{nd} part examines results from the first and second pass of the coding of the data, as well as the frequencies of the data.

Demographics of Allopathic Medical Schools in United States

In this section, demographic data, including size of medical school by number of students enrolled and numbers and classifications of medical school regional campuses is presented.

Size of Medical Schools by Student Enrollment

As of the 2017-2018 academic year, there were 87,766 medical students at the 143 allopathic medical schools in the United States (Association of American Medical Colleges, 2017). The AAMC report counted students from all years of the medical program, including students on a leave of absence. It did not include students with graduated, dismissed, withdrawn, deceased, never enrolled, or degree-revoked statuses. The author split the medical schools into thirds (small, medium, and large-sized medical school) based on the total number of medical students enrolled at each medical school. This was accomplished by organizing the enrollment numbers from each medical school in order from lowest to highest. These numbers ranged from sixty (60) students at the smallest-sized medical school, to 1,460 students at the largest-sized medical school. Then, the medical schools were split into thirds, almost equally. Forty-eight (48) medical schools had enrollments under 485 medical students, and thus were considered “small-sized.” Forty-seven (47) medical schools had enrollments between 485-725 medical students and were considered “medium-sized.” Finally, forty-eight (48) had more than 725 medical students and were considered “large.”

Regional Campuses of Medical Schools

Table 4.1 presents the types of regional campuses that were found through careful analysis of the medical school websites. They are divided into the following categories: 1) Only One Campus, where there are no other campuses affiliated with that medical university, 2) >1 Campus, other campuses are for clerkship years, 3) >1 Campus, Same Curriculum, where there is more than one campus but all campuses follow the same curriculum in the pre-clinical years, 4) >1 Campus, Different Curriculum, where there is more than one campus, but at least one campus has a different curriculum from the main campus in the pre-clinical years, and 5) Unique Campus. The unique campuses were medical schools which may have been in partnership with a larger medical institution, but the campus had a distinct enough curriculum from the partnered university to be considered their own separate medical program. Two medical institutions fit the classification of “unique campus.” These two institutions were Cleveland Clinic Lerner College of Medicine in Cleveland, Ohio and University of California Berkeley/University of San Francisco (UC Berkeley/UCSF) Joint Medical School. Cleveland Clinic medical school partners with Case Western Reserve University School of Medicine, but it has its own website and curriculum (Cleveland Clinic Lerner College of Medicine, 2018). The UC Berkeley/UCSF medical program is associated with the website of UC-Berkeley, but it its curriculum was distinct enough to be considered as a separate institution (Joint Medical Program, 2018). Other criteria for classifying this program as a distinct medical program included: 1) UCSF having its own medical program, which was much different from the UC Berkeley/UCSF medical curriculum , 2) UC Berkeley did not have its own medical program, and 3) According to its website, the UC Berkeley/UCSF Joint program students spent the majority of their time at UC Berkeley.

Medical schools may fall into more than one of these categories of types of regional campuses. For example, The Medical College of Georgia has its main campus in Augusta. However, it has an additional campus in Athens, which follows a different curriculum. Additionally, the college has campuses dedicated to the clerkship years in Albany, Rome, and Savannah, Georgia (Medical College of Georgia, 2018).

The majority of medical institutions (114, or 78.6% of the 145 total medical schools) were found to have a single campus. Twenty-two (22) medical schools (15.2%) contained more than one campus, with some campuses being used for clerkship years. Nine (9) medical schools (6.2%) had more than one campus that followed the same curriculum, with two (2) medical schools (1.4%) with more than one campus and following a different curriculum. Finally, there were two (2) medical programs (1.4%) that were considered unique campuses, which were partnered with a campus but had their own medical curriculum and program.

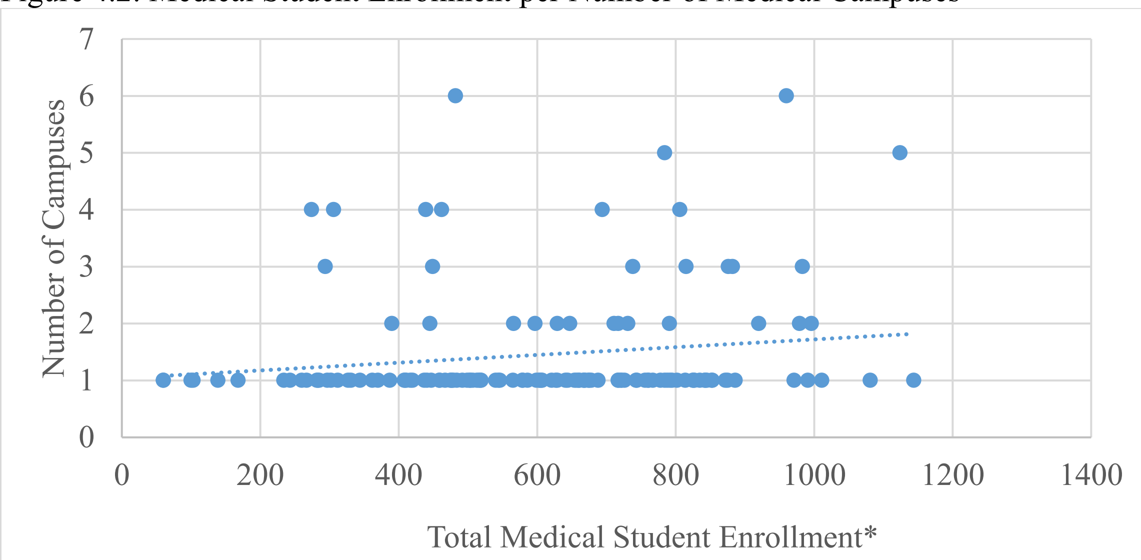
Table 4.1: Regional Campus Categories of US Allopathic Medical Schools

Classification of Medical School Regional Campuses	**Only One Campus**	**> 1 Campus, including campuses for clerkships**	**>1 Campus, Same Curriculum**	**>1 Campus, Different Curriculum**	**Unique Campus****
Number of Medical Schools*	114	22	9	2	2
%	78.6	15.2	6.2	1.4	1.4

n =145 medical schools, including the 2 unique campuses
*total is 149 because medical programs may be in more than one category
**differs from first column in that it was affiliated with a separate university but has its own medical program

Figure 4.2 displays enrollment data from each allopathic medical school in the United States as well as the number of regional campuses at each medical school to see if there was any association between these data, and thus if an association could impact the type of curriculum a medical school follows. An interquartile range was calculated with the data to determine if there were any outliers (Field, 2013). Three medical schools were removed from the final correlation analysis because their student enrollment was considered an outlier. The number of regional campuses per medical school was not divided up into any specific categories like they were in Table 4.1. If a medical school had any type of regional campus, it was included in the data set. After running a Pearson's r correlation on the data, there was a positive relationship found, but it was very weak and not statistically significant at the 0.05 level ($r = 0.152$, $p = 0.073$). These data show that as the student enrollment increased at a medical school, there was not a large increase in number of campuses a medical school contains. From the data, we can rebut the argument that schools with regional campuses have a certain type of curriculum because their enrollment is large. A medical school will have a certain type of curriculum due to many other reasons that will become apparent in Chapter 5 of this dissertation.

Figure 4.2: Medical Student Enrollment per Number of Medical Campuses



n = 140 medical institutions

*Unique curricula from Table 4.1 not included because their population was part of the parent institution

As the number of student increase at a medical school, there is a very small increase in the number of regional campuses, but this association is not very strong.

The allopathic medical institutions were not only divided by student enrollment and regional campuses for the sake of this research, but they were also divided by region of the United States. The author did not devise these regions herself. Rather, the Association of American Medical Colleges had already divided American and Canadian medical colleges into four different regions: Central, Northeast, Southern, and Western (AAMC, 2018). The Canadian medical schools were removed from the count, as this research only focuses on medical schools from the 50 United States and the District of

Columbia. Table 4.2 displays the geographic distribution of allopathic medical school in the United States. This data set is referenced in Chapter 5, by viewing the medical schools and regions represented from the survey.

Table 4.2: Geographic Distribution of Allopathic Medical Schools in the US

AAMC Region of Medical School	**Central**		**Northeast**		**Southern**		**Western**	
State and # Medical Schools (n=145)	IL	7	CT	3	AL	2	AZ	2
	IN	1	DC*	3	AR	1	CA	11
	IA	1	MA	4	FL	7	CO	1
	KS	1	MD	3	GA	4	HI	1
	MI	6	NH	1	KY	2	NM	1
	MN	2	NJ	3	LA	3	NV	2
	MO	4	NY	14	MS	1	OR	1
	ND	1	PA	7	NC	4	UT	1
	NE	2	RI	1	OK	1	WA	2
	OH	7	VT	1	SC	3		
	SD	1			TN	4		
	WI	2			TX	10		
					VA	4		
					WV	2		
Total # of medical schools in region	**35**		**40**		**48**		**22**	

n = 145, including 2 unique medical programs mentioned in Table 4.1

While much of the above data will be used in some manner to see, for example, how many faculty from each region of the United States answered the survey, and what enrollment numbers are for their institutions, more of these data will be used for future research in this area. This is discussed in more detail in Chapter 7 under *Future Directions.*

Results of Qualitative Content Analysis of US Allopathic Medical School Website Data

In this section, the first pass coding terms will be presented, followed by the second pass terms will be presented. Finally the codes and sub codes will be presented in their entirety along with the total percentages of each code found from the medical school websites.

First Pass of Data

The a priori codes that were found during the first pass of the data are seen in the top of Table 4.3, and included "integration," "systems," "discipline," and "basic science." These codes were deemed to be important from the literature because when medical schools underwent curricular reform, there was a change to more integrated (with basic sciences), systems-based curriculum and a move away from discipline-based curriculum (Brooks et al., 2015; Halliday et al., 2015; Lazarus et al., 2014). These codes were used on many of the websites of the medical schools in their curricular descriptions. Additionally, one first pass code was added, after going through the website data to confirm that it was present, and this code was describing the curriculum as "new" within the last 10 years. For some schools, such as the University of Nevada-Las Vegas School of Medicine, that meant that the entire school itself was new within the last 10 years (University of Nevada-Las Vegas School of Medicine, 2018). For other schools, such as Rush Medical College, the curriculum was revised within the last 10 years, so that was considered a "new" curriculum (Rush Medical College, 2018). The number 10 was chosen for the maximum number of years since curricular reform occurred at the medical university because research from Brauer and Ferguson (2015) has shown a large increase in the term "integration" in the literature in the past ten years (since 2009) meaning that many universities (though not all of them medical universities) have revised their curriculum to be more integrated.

These a priori*,* first pass codes, were only used as a basis to start the coding process of the website data. Upon further analysis of medical websites, some of the first pass codes were combined, such as integration and basic science. The second pass of the data shows how the a priori codes were utilized and expanded to include data from the medical school websites.

Second Pass of Data

After going through the website data a second time, it was determined that the data should be split into three parts: the type of integration a medical curriculum has, how the courses are organized within that curriculum, and whether the medical curriculum is new within the last 10 years. These three parts were referred to as the primary codes during the second pass, with “integration” being one code, “organization of curriculum” being the second code, and “new medical curriculum in last 10 years” being the final code. Each of these three codes had sub codes which further described the codes.

This second pass analysis resulted in thirteen (13) descriptions (sub codes) for integration including the following: vertical, horizontal, and vertical and horizontal (spiral) integration; integration of basic and clinical sciences; integration of courses; integration of clerkships; integration of organ systems; integration of learning modes; integration of subjects; integration of concepts; integration of normal and abnormal; integration used alone; and an “other” integration that didn’t fit into any of the descriptive sub codes above. The second pass sub codes are shown at the bottom of Table 4.3.

For organization of curriculum, there were eight (8) different sub codes found from the website data including the following: organ systems-based approach, full or most organ systems courses, discipline approach, and topic approach; having 2, 3, or 4 phases of the curriculum; using the term block, unit, or module; having a named curriculum; and having an "other" type of curriculum that didn't fit into any of the descriptive sub codes above.

The final second pass code was "New medical curriculum in last 10 years." This code was originally placed in the organization of curriculum code; however, after much thought, it was decided that this was an important aspect of the medical curriculum, that it needed its own distinction. There were two (2) sub codes found for this code: new medical school and only new medical curriculum.

The codes and sub codes presented in Table 4.3 are a general overview of what is discussed in the next section of this chapter in more detail.

Table 4.3: Description of Coding Terms used for Medical School Website Analysis

First Pass Codes	Integration/integrated/integrate
	Systems
	Discipline
	Basic Science
	Describing the curriculum as "new" in the last 10 years
Second Pass Sub Codes for Integration	Vertical integration
	Horizontal integration
	Horizontal and vertical (spiral) integration
	Integration of basic and clinical sciences
	Integration of courses
	Integration of clerkships
	Integration of organ systems
	Integration of learning modes
	Integration of subjects
	Integration of concepts
	Integration of normal and abnormal
	Integration alone
	Integration other
Second Pass Sub Codes for Organization of Curriculum	Organ systems-based approach

	Full or most organ systems courses
	Discipline approach
	Topic approach
	Phases of the curriculum: 2, 3, 4
	Use term block, unit, or module
	Having a named curriculum
	Other
Second Pass Sub Codes for New Medical Curriculum in Last 10 Years	New medical school
	Only new medical curriculum

Once the codes and sub codes were found from the medical school websites, the author created a key for those terms. Numbers were designated for each "integration" sub code and letters for each "description of curriculum" sub code. The numbers 1-14 were designated for the classifications of integration, the letters A-J were designated for the organization of the courses or for the entire curriculum, and the letters i and ii were designated for the new medical curriculum in last 10 years code. Each medical school listed in Appendix A received a combination of letters and numbers for their curricular descriptions. These terms were then tallied, and percentages were found by dividing the frequency of the terms by the number of distinct medical curricula (147). These data are displayed in Table 4.4.

Table 4.4: Key, Examples, and Percentages for Classification of Medical Curricula, Per Medical Schools' Websites

Number or Letter of Key	**Sub Code**	**Example of how curriculum was described on website**	**Percentage of medical school websites that used these terms (n = 147)**
Classification of Integration			
1	Integration, any way	If the website said "integration" in any manner	91.8
2	Vertical integration	Used exact term	4.1
3	Horizontal and vertical (spiral) integration	Used those exact terms	5.4
4	Horizontal or longitudinal integration	Used either term	1.4
5	Integration alone	Only used "integration" without other explanation	3.4
6	Integration of basic and clinical sciences	Usually used those exact terms	55.8
7	Integration of courses	Used those exact terms	23.8
8	Integration of (longitudinal) clerkships	Used those exact terms	27.2
9	Integration of organ systems	Used those exact terms	16.3
10	Integration of learning modes	integration of PBL, TBL, small group learning, dissection, etc.	12.9
11	Integration of subjects or disciplines	May not be exactly integration of courses, but might say "integration of anatomy and histology topics"	36.1
12	Integration of concepts	"integrated instruction of all competencies"	56.5
13	Integration of normal and diseased (normal and abnormal) state	Used those exact words	11.6
14	Integration other	"fully integrated biopsychosocial approach"	11.6

Organization of courses/ entire curriculum			
A	Organ systems approach or organ systems-based description	Classes organized around organ systems	56.5
B	Full or most systems courses	Course listings included courses entitled “Cardiovascular System”, “Respiratory System”, etc.	57.1
C	Topic-based courses	Organized around a topic or concept as opposed to an organ system or discipline. E.g., “Human Structure” or “Fundamentals of the Human Body”	57.1
D	Discipline-based courses	Organized around specific subjects, such as gross anatomy, physiology, and biochemistry	18.4
E	Use of the term block/unit/module	Used those exact words	59.2
F	2 phases of the curriculum	Used those exact words	3.4
G	3 phases of the curriculum	Used those exact words	21.8
H	4 phases of the curriculum	Used those exact words	8.2
I	Other type of curriculum	Description included in the table in the appendix. e.g., at the University of California-Berkeley/University of San Francisco Joint Medical School, they engage in a “Learner-led PBL classroom curriculum” where students receive a concurrent Master’s in Health and Medical Sciences	23.1

J	Named curriculum	The medical school has given a name to their curriculum. E.g., at the University of Connecticut Medical School, their curriculum is named “M Delta Curriculum”.	27.9
New Medical Curriculum in Last 10 Years			
i	New medical school in last 10 years	Entire new medical school created	13.6
ii	Only new curriculum in last 10 years	Not a new medical school but a new curriculum	24.5

"Integration" in any manner was designated as an individual sub code so the author could quantify how many schools used the term "integration" at all in the curricular descriptions (regardless of whether or not the curriculum was truly integrated). In other words, did the medical school advertise the curriculum as integrated, even if the website data did not back up this statement? This term of 'integration' was given the number "1" from the key. If "integration" had no other descriptor after it, it was given the sub code of "integration alone" and was given the number "5." For the terms of "vertical" (2), "horizontal" (4), and "horizontal and vertical (spiral)" (3) integration, the curricular description would use those exact terms.

Other sub codes that were generated due to websites using those exact codes were terms such as "integration of basic and clinical sciences" (6) and "integration of courses" (7). The "courses" that may have been integrated for that description could have been any number or type of courses, but the verbatim description stated exactly that. Additionally, the terms "integration of (longitudinal) clerkships" (8) and "integration of organ systems" (9) had that exact terminology in the curricular description.

Some of the sub codes generated that were not directly from the curricular descriptions included "integration of learning modes" (10). This curricular term may have been integration of many different learning modalities such as lectures, problem-based learning, and small groups. A description from the University of New Mexico School of Medicine includes,

> "**integration** of the basic sciences and clinical medicine, **early exposure to patients and communities to enhance teaching and learning, progressive development of clinical reasoning skills through a problem-based approach, emphasizing professional identity formation, and attention to personal and professional wellness**" (University of New Mexico School of Medicine, 2018).

In this description, there was the direct quote of "integration of basic sciences and clinical medicine" as well as integration of the rest of the learning modalities to accomplish the integration of basic and clinical sciences.

Another sub code that was not a verbatim description included "integration of subjects of disciplines" (11). For many medical schools, they explained that many of their basic science courses were integrated, and then they listed those disciplines. For example, at the University of Massachusetts Medical School, they stated,

> "Developmental Structure and Function **integrates gross and clinical anatomy, physiology, histology and development** into a 260-hour, 5-month course beginning in the third month of year 1" (University of Massachusetts Medical School, 2018).

"Integration of concepts" (12) included integration of learning ideas or values (but not specific learning modes), information presented in courses (though not specific courses), or just general integrated content. For example, at the University of Michigan Medical School, "students review **actual patient cases with scientific content that is integrated with your foundational curricular sequences**" (University of Michigan Medical School, 2018).

For the sub code of "integration of normal and diseased state" (13), the curricular description either read exactly that, or it was a variation on that, such as "integration of normal and abnormal state." A final sub code of integration was "integration other" (14). This was any type of integration that could not be placed in any other category. At Florida State College of Medicine, they described their pre-clerkship curriculum as "undergone a major redesign – from a traditional, discipline-based curriculum – anatomy, biochemistry, physiology, etc. – to a fully **integrated biopsychosocial model"** (Florida State University College of Medicine, 2018). This "integrated biopsychosocial model" could not be placed with any other sub code, so it was decided to place it into “integration other.”

For the organization of courses/entire curriculum code, there were two sub codes that are very similar: “organ systems approach or organ systems-based description” and “full or most systems courses.” The “organ systems approach,” designated with the letter “A” from the key, was usually a direct quote from the website curricular description; whereas the “full or most systems courses,” designated with the letter “B,” was seen from the curricular map. For many medical schools, there was both a description of the courses taught in the pre-clerkship years as well as a curricular map outlining when those courses were taught throughout the year. An example of an organ systems course could be “Cardiovascular System” or “Respiratory System.” In contrast, an organ systems-based description could be “the ACE Curriculum consists of an integrated block structure **based on organ systems** that systematically introduces foundational and clinical content across the four years” (University of Kansas School of Medicine, 2018). Not only did this medical school have an organ systems-based description of the curriculum, but it also had organ systems courses, seen on its curricular map (Figure 4.3).

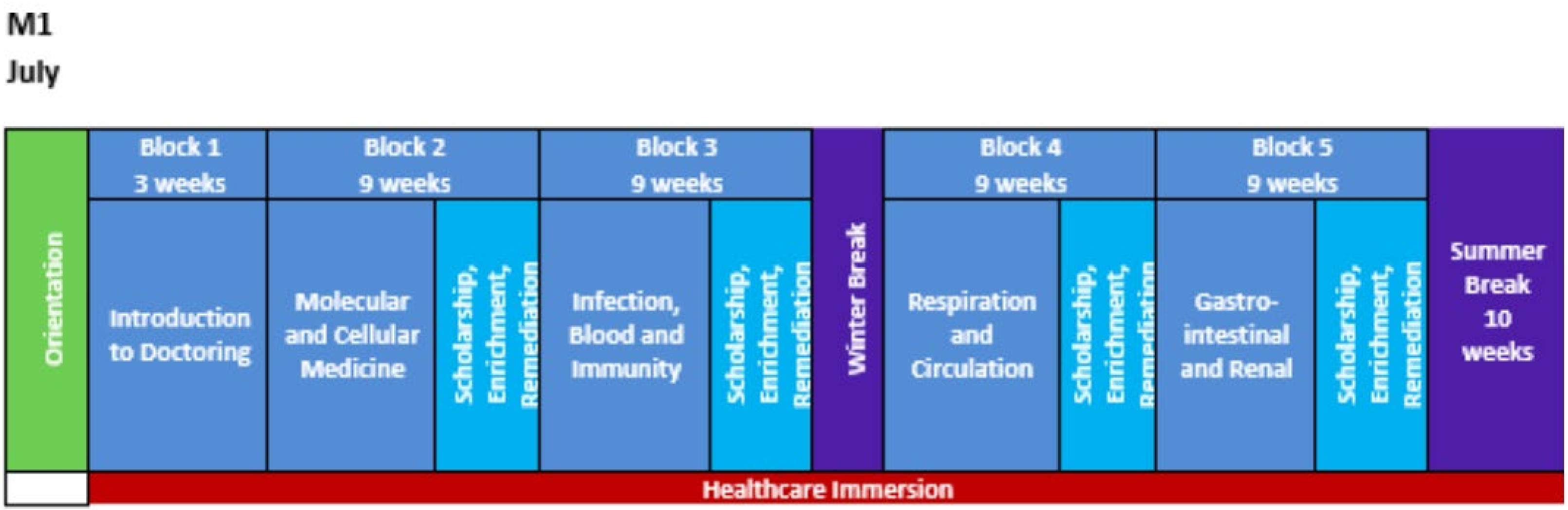
Other ways that a medical school’s courses were organized was through topic and discipline-based courses. Topic courses (C) are those with a topic-based name, and they usually incorporate more than one discipline. The topic-based course might be organized around different organ systems, but one topic-based course usually does not cover one organ system, like an organ unit course might. Figure 4.4 shows a curricular map from West Virginia University School of Medicine and how topic-based courses are organized within the first year (West Virginia University School of Medicine, 2018). An example of a topic-based course from West Virginia University School of Medicine is called Human Structure, which integrates gross anatomy, histology, and embryology.

Discipline-based courses (D) were primarily singular courses organized around one discipline, such as anatomy, cell biology, or physiology. Figure 4.5 shows a curricular map from East Tennessee State University medical school that was organized primarily by discipline-based courses (East Tennessee State University College of Medicine, 2018).

If a medical school curricular description used the term "block," "unit," or "module," it was marked as the letter "E" from the key. These terms were usually used to describe how the courses in the curriculum were organized, such as in blocks. At the University of Nebraska College of Medicine, the courses there are called blocks (University of Nebraska College of Medicine, 2018).

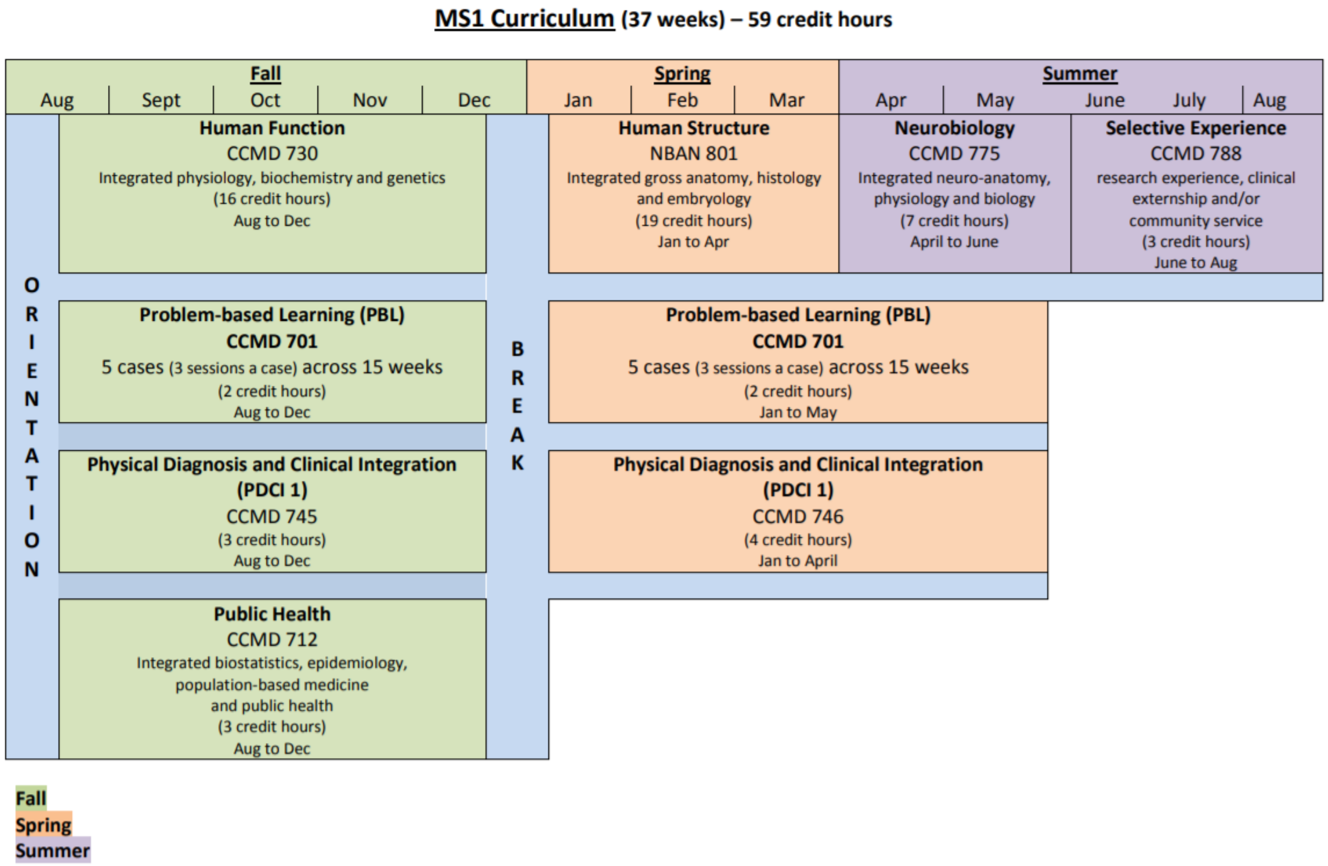
A medical school may also organize its entire curriculum into phases. There were some medical schools with 2 phases, marked "F" from the key, 3 phases, marked "G," or 4 phases, marked "H." One example on how a medical school organized its curriculum into phases is from the University of North Carolina School of Medicine, seen in Figure 4.6 (University of North Carolina School of Medicine, 2018). Phase 1, called the Foundations Phase, encompassed the pre-clerkship curriculum of years 1-2 of medical school. Phase 2, the Application Phase, was for the clerkships in the beginning of the 3rd year of the medical program. Phase 3, the Individualization Phase, was for the electives at the end of 3rd year and into 4th year of the medical program.

Figure 4.3: Curricular Map for Year 1, University of Kansas School of Medicine



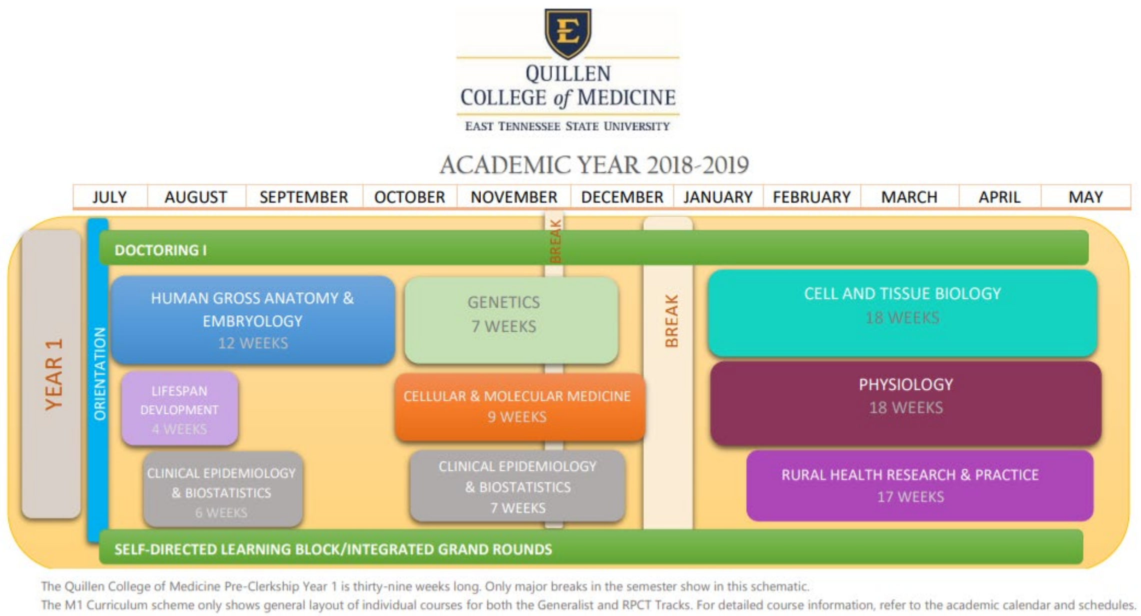
This curricular map from University of Kansas School of Medicine shows systems courses such as Respiration and Circulation and Gastrointestinal and Renal

Figure 4.4: Curricular Map for Year 1, West Virginia University School of Medicine



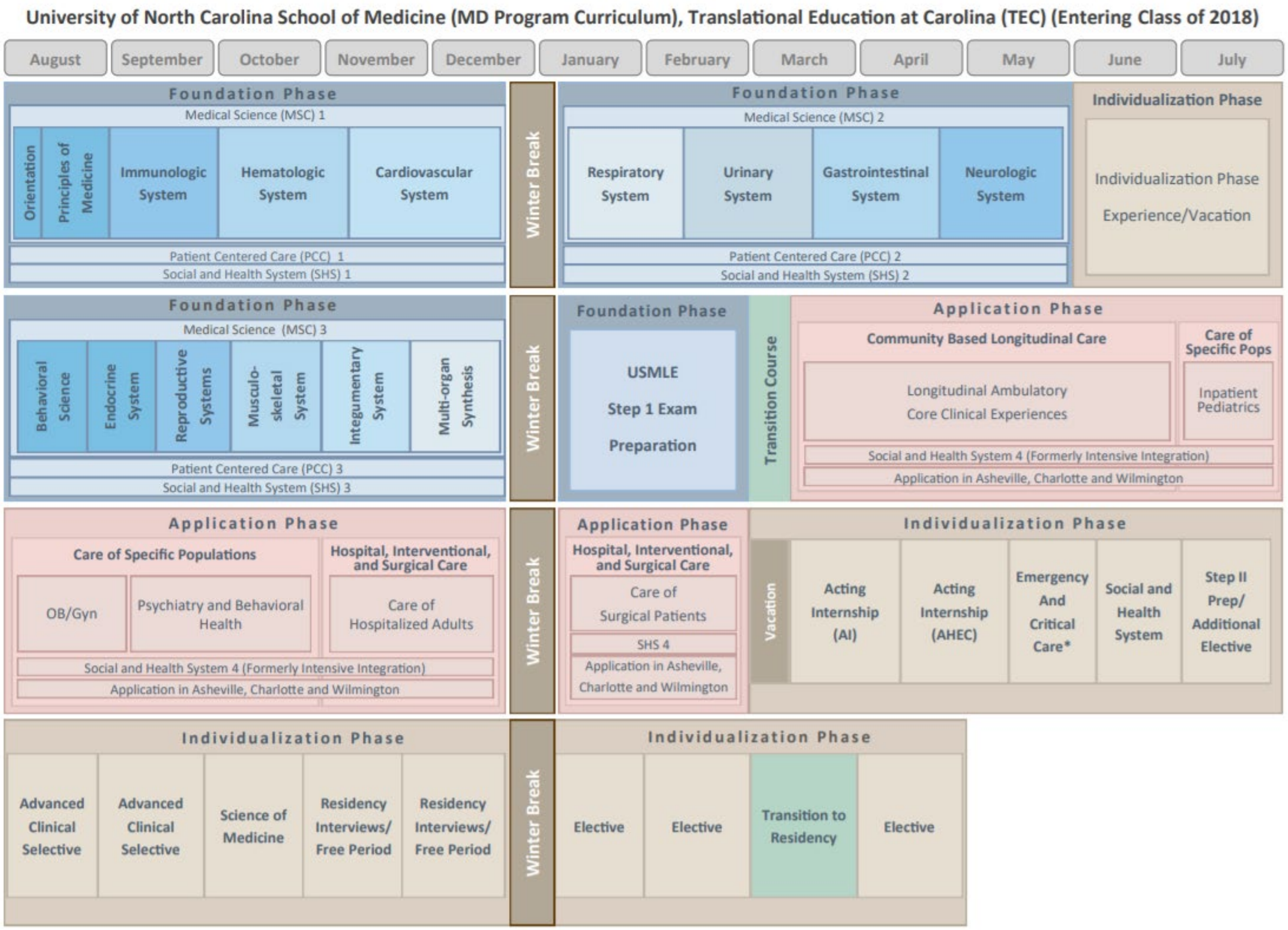
Curricular map for West Virginia University School of Medicine which shows topic-based courses such as Human Function which integrates biochemistry, genetics and physiology and Human Structure which integrates gross anatomy, histology, and embryology.

Figure 4.5: Curricular Map for Year 1, East Tennessee State College of Medicine



This curricular map shows how courses in year 1 at East Tennessee State medical school are discipline based, such as Physiology and Genetics course

Figure 4.6: Curricular Map from University of North Carolina Medical School



This curricular map shows how the entire curriculum from the University of North Carolina School of Medicine is divided into three phases: Phase 1: Foundations, pre-clerkship phase. Phase 2: Applications Phase, and Phase 3: Individualization Phase

If a medical school had a curriculum that was different from other medical schools' curricula, then that would be considered an "other type of curriculum" (I) for this research. For example, at the University of California-Berkeley/University of San Francisco Joint Medical School, the curriculum was considered a "Learner-led PBL classroom curriculum" where students received a concurrent Master's in Health and Medical Sciences (Joint Medical Program, 2018). The letter "J" from the key was given to medical curricula that were uniquely named. For instance, at the University of Connecticut medical school, their curriculum was named "M Delta Curriculum" (University of Connecticut School of Medicine, 2018).

Another code that was discovered during the website analysis was for "New Medical Curriculum in Last 10 Years." In this code, there were two sub codes discovered: "New medical school in last 10 years" (i) and "Only new curriculum in last 10 years" (ii). The examples differentiating a new medical school from a new medical program are described above under the description of first pass codes. The University of Nevada-Las Vegas School of Medicine was a new medical school as of 2017 (University of Nevada-Las Vegas School of Medicine, 2018). Rush Medical College had its curriculum revised in 2010, so that was considered a "new" curriculum (Rush Medical College, 2018).

Of the 147 distinct medical curricula, the sub code of "integration" was by far the most popular term used by curricular websites (135; 91.8%). Of "vertical," "horizontal," and "spiral" integration, spiral was the most common (8, 5.4%) followed by vertical (6, 4.1%) and then horizontal (2, 1.4%). Five (5, 3.4%) medical curricula had no other descriptors after "integration" or "integrated curriculum."

Of the other types of integration, “integration of concepts” was the most popular with medical curricular descriptions (83, 56.5%), followed closely by “integration of basic and clinical sciences” (82, 55.8%). “Integration of subjects or disciplines” was the next most common (53, 36.1%), followed by “integration of (longitudinal) clerkships” (40, 27.2%), and “integration of courses” (35, 23.8%). The next most common sub code for medical curricula was “integration of organ systems” (24, 16.3%) and “integration of learning modes” (24, 16.3%). “Integration of normal and abnormal” and “integration other” were tied for being the least common sub code with seventeen (17, 11.6%) medical curricula using that descriptor.

Eighty-three (83, 56.5%) of the medical schools reported that they organized their curricula according to organ systems. Additionally, eighty-four (84, 57.1%) medical curricula had full or most organ systems courses, and eighty-four (84, 57.1%) curricula had topic-based courses. Discipline-based courses were included in twenty-seven (27, 18.4%) medical programs. These percentages of full organ systems, topic-based, and discipline-based courses do not add up to 100% because medical curricula may have a combination of these types of courses. For example, at Indiana University School of Medicine (IUSM), there are topic-based courses in the first year of the program, and organ systems courses in the second year of the program (Indiana University School of Medicine, 2018), so for that example, both full or most organ systems and topic-based courses would be marked for IUSM’s curricular description.

Over half of the medical curricula (87, 59.2%) used the term “block, unit, or module” in their curricular description. For the phase designations, only five (5, 3.4%) curricula were divided into 2 phases. Thirty-two (32, 21.8%) were divided into 3 phases, and twelve (12) were divided into 4 phases. Thirty-four (34, 23.1%) medical curricula did not fit in one of the other descriptors, so they were considered “other type of curriculum.” Forty-one (41, 27.9%) curricula had a specific name.

For the final code of new medical school in the last 10 years, there were a total of fifty-six (56) medical schools that were either a new medical school or a new medical program. Of the 147 total medical programs as of 2017-2018 school year, twenty (20; 13.6%) medical schools were new in the last 10 years, and thirty-six (36; 24.5%) had a new medical curriculum in the last 10 years.

Now that the data on the common methods used in medical curricula have been presented, it’s important to understand what all of the data means, and what the implications of the data can mean for medical schools who want to revise their curricula. What are the best ways to organize a medical curriculum? What does integration actually mean? These questions are answered in the next section of this chapter. The author breaks down the components of an ideal medical curriculum and proposes a schema that medical schools may follow to design their own curricula.

Analysis of Curricula at US Allopathic Medical Schools – What does the descriptive data tell us?

Many allopathic medical schools in the United States designed their curriculum in vastly different ways than others. There are many different ways to both integrate a curriculum and organize the entirety of the curriculum, as seen in the literature (Barrows and Tamblyn, 1980; Brauer and Ferguson, 2015; Halliday et al, 2015; and Papa and Harasym, 1999).

The curricular descriptions from medical schools addressed research question one (below), and it used the information found to generate codes and sub codes and frequencies of those codes from the content analysis of the data.

Research Question 1: How do American medical schools granting a medical doctorate degree classify their curricula (e.g., horizontal, vertical, or spiral integration, problem-based learning curriculum, basic science integration, organ-systems based, etc.)?

The data collected and analyzed via the curricular descriptions from the medical school websites provided valuable information on the various ways curricula can be integrated and organized. Based on the coding scheme used in this study, there were thirteen (13) different ways that information in the medical curriculum could be integrated, and there were eight (8) different ways in which the courses taught within the curriculum or the curriculum itself could be organized or described.

The analysis of medical school websites showed that many medical schools contain a combination of the different methods of integration and organization of a curriculum. For example, Florida International University Herbert Wertheim College of Medicine (2018) curriculum is spirally integrated and has integration of courses and concepts. Additionally, the medical program at the Florida International University contains a combination of organ systems-based description of courses, organ systems courses, and topic-based courses.

Further analysis of the data was completed to see if there were any trends in curricular organization at the medical schools – for example, if a medical school integrated in a certain manner, was an organ systems-based curriculum the more common way to organize the courses? The author chose the sub code “integration of basic and clinical sciences” to discover if there was a trend. This sub code was chosen because it was the most popular integration term used in curricular descriptions on medical school websites. A Chi square test of independence was run on this data set to discover if there was a trend in using “integration of basic and clinical sciences” and having a specific type of organization of medical curriculum (organ systems or topic-based). Discipline-based curricula were not further analyzed due to the small number of medical programs utilizing that distinction.

When looking at medical schools that had both “integration of basic and clinical sciences” and systems-based curriculum, there were forty-one (41) out of 147 medical curricula (27.9%) that had that combination. The results of the Chi square test were not found to be statistically significant, $\chi^2 = (1, N = 147) = 2.51$, $p = 0.113$. When looking at the data for curricula having “integration of basic and clinical sciences” and topic-based courses, there also were no statistically significant relationships, $\chi^2 = (1, N = 147) = 2.50$, $p = 0.114$. For this combination, fifty-one (51) of 147 medical programs (34.7%) had both the integration factor and topic-based curricula. This analysis shows that there was not a statistically significant association between the more common type of integration and organization of the medical curriculum.

Additional analysis of the data was completed to see how specifically gross anatomy was incorporated into the curriculum, and how specifically the courses were topic-based courses into their curriculum, but this further analysis, seen in Table 4.5, shows the specific organization of pre-clerkship courses.

Gross anatomy was organized into the medical curriculum many different ways. Looking at the 147 allopathic medical programs in the United States, the most common way to teach gross anatomy was through topic-based courses (please see Table 4.4 for examples of topic-based courses) (48; 32.7%), followed by a combination of topic and systems (31; 21.1%), systems (26; 17.8%), discipline (22; 15.0%), and discipline and systems (4; 2.7%). In the programs where gross anatomy was taught in two different types of courses, the subject material was first introduced early in the medical curriculum, and then it was taught within the systems-based courses later in either the second semester of the first year or within the second year of the medical program.

For the organization of the medical courses, out of the 147 allopathic medical programs in the United States, it was found that most of the courses (59; 40.1%) were taught by systems, except for 1-2 foundational courses early in the first semester of the medical program. The second most common way (28; 19.0%) was for all first-year courses to be organized by topic and the second-year courses to be organized by system. Only 25 (17.0%) of medical programs teach all topic-based courses, 10 (8.8%) teach all systems-based courses, and only 4 (2.7%) teach all discipline-based courses. Other ways to organize courses included first year discipline-based and second year systems (4; 2.7%), and combination (4; 2.7%), which included a mix of discipline, topic, and systems-based courses.

Table 4.5: Organization of Gross Anatomy within Medical Curricula

	Curricular Organization	Percentage of Medical Schools using this approach (n = 147)
Gross Anatomy	Systems	17.8%
	Topic	32.7%
	Discipline (Stand-alone)	15.0%
	Topic and Systems	21.1%
	Discipline and Systems	2.7%
	No information	10.9%
Overall Courses	All Systems	8.8%
	All Topic	17.0%
	All Discipline (Stand-alone)	2.7%
	1-2 intro courses and rest systems	40.1%
	1st year topic; 2nd systems	19.0%
	1st year discipline; 2nd systems	2.7%
	Combination of discipline, topic, and systems	2.7%
	No information	6.8%

These data align with data found by the AAMC and LCME in a survey sent to medical schools. From the 2017-2018 year, of 147 medical programs, 130 (88.4%) had organ systems-based organization in some manner (possibly in some combination of courses organization from the paragraph above), while only 70 (47.6%) had discipline-based organization in some manner (LCME Annual Medical School Questionnaire Part II, 2017-2018). Thus, organizing a medical curriculum by organ systems blocks is very common now.

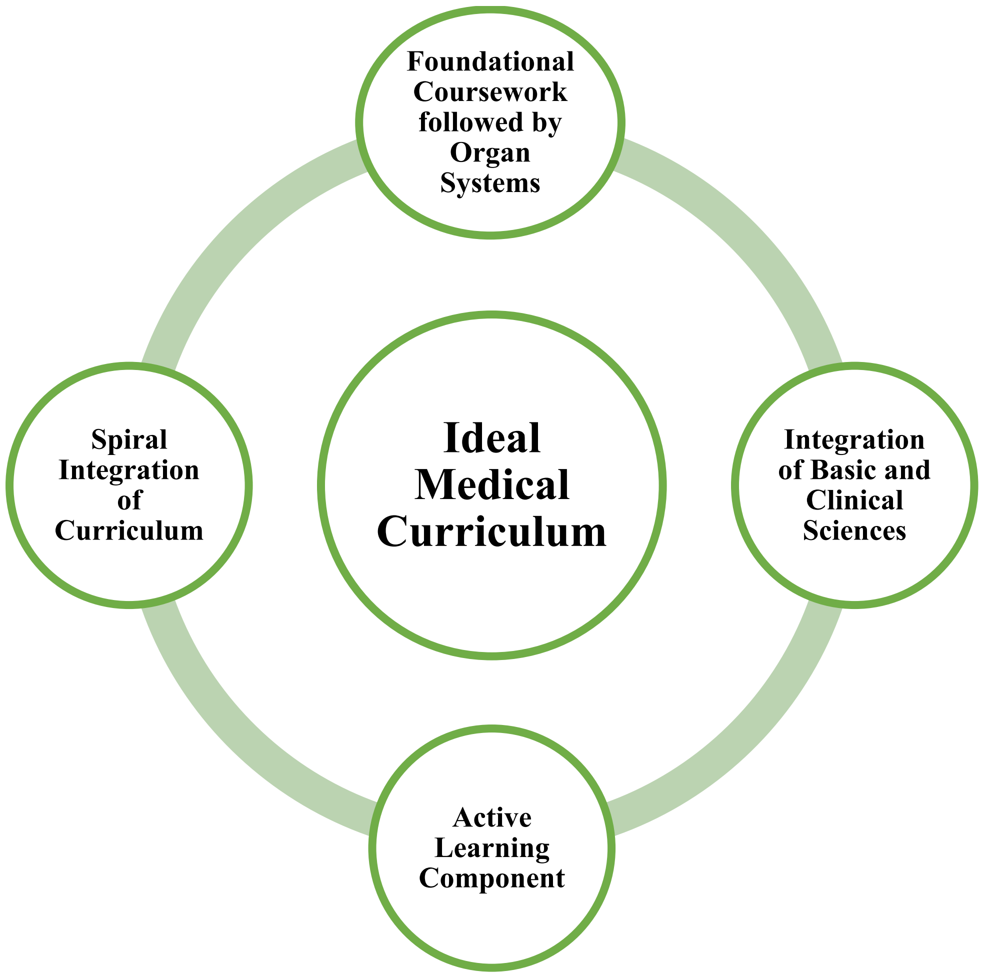
The data show that while a medical program may promote itself as having an "organ systems-based curriculum," not all those courses are (or should) be taught by organ systems. Students most commonly attain foundational basic science knowledge, including gross anatomy knowledge, through topic-based courses, and then that foundational knowledge is integrated into organ systems-based courses (Cooke el al., 2010; Klement et al., 2017).

The results presented in this research may differ from previous research in that authors such as Brauer and Ferguson (2015) may have classified their integration models into a few conceptually-related groupings as a way to simply frame their findings. The present study took a more comprehensive approach in evaluating medical curricula by including additional levels of integration and the multiple ways the terms from this research may combine to produce distinct curricula. The research from Papa and Harasym (1999), while useful to view a general classification of medical curricula, is twenty years old at the time of the writing of this research. Extensive curricular change has occurred since that time, as evidenced by the fifty-six (56) new medical curricula created, including the 20 new medical schools which opened, in the last ten years.

Medical Curricular Schema

Now that the general organization of curricula from allopathic medical schools in the United States has been presented, the author proposes an ideal medical curricular schema to utilize when designing a medical curriculum. Cooke et al. (2010) described how the first two years of a medical program do not have to be uniform across all medical schools, but that there are still important aspects that need to be retained, including integration of foundational knowledge and clinical experiences. The author proposes four components that should be considered when designing the pre-clerkship medical curriculum. These components are presented in Figure 4.7 and are further discussed in the conclusions of this research in Chapter 7.

Figure 4.7: Proposed Medical Curricular Schema Model



These four guidelines are interconnected – one does not fully stand out from another, and they all need each other in order to form a cohesive unit. These guidelines are discussed in the following paragraphs, but they are presented in no particular order because they are all of the same importance.

It should be noted that in the explanation of these four guidelines, only six types of integration were explicitly described (integration of basic and clinical sciences; vertical, horizontal, and spiral integration; integrated systems-based blocks; and integration of learning modes), and in the curricular schema model itself, only two types of integration were presented. This contrasts with the 13 ways in which integration was used in medical curricular website descriptions. These 13 integration descriptions may be condensed in the creation and classification of a medical curriculum. For instance, for “integration of courses,” and “integration of disciplines” that is already demonstrated in the guideline about how content should be organized, where courses (such as pathophysiology and pharmacology) are integrated together and taught around an organ system.

The general term of “integration” is jargon-laden, in that many medical schools will use this term in their curricular descriptions without actually chronicling how specifically the curriculum integrates material, through a curricular map or other specific explanations of the courses in the curriculum. One primary example is from the sub code of “integration of concepts.” This sub code was described as integration of learning ideas or values (but not specific learning modes), and many medical schools used a wide variety of ways to demonstrate integration of concepts. However, most of the medical programs that were coded with “integration of concepts” did not explicitly describe the process of integrating concepts into the medical curriculum. This is an example of an integrative term that is very abstract.

For this research, the author uses the definition of integration defined by Harden et al. (1984): “the organization of teaching matter to interrelate or unify subjects frequently taught in separate academic courses or departments” (pg. 288). In the proposed curricular schema, the author identifies and explains discrete types of integration that should be incorporated into the medical curriculum. Additionally, examples are given on how medical programs may incorporate these guidelines into their own medical curricula.

Guideline 4.1: There should be integration of basic and clinical sciences in the medical curriculum.

One of the most common ways that was found in the analysis of website data was the integration of basic and clinical sciences. It was found that 55.8% of all medical programs utilized the term "integration of basic and clinical sciences" to some degree. Teaching the clinical sciences along with the foundational basic sciences is a vital aspect of the medical curriculum, especially during the pre-clerkship years when students are beginning to learn the ways in which to treat patients. This important time in a medical student's career is not only a time to learn about the human body, but also how to treat the human body. Cooke et al. (2010, pg. 216) proposed similar guidelines for the incorporation of clinical experience:

- Closely connect formal knowledge and clinical experience, including provisions of early clinical immersion and later revisiting of the sciences
- Examine diseases and clinical situations from multiple perspectives
- Give learners access to different roles and responsibilities of physicians
- Promote learner' ability to work collaboratively with other health professionals to effectively deliver patient care in complex systems

Students need to not just know the foundational knowledge related to their coursework, but they need to be able to apply that knowledge in a clinical setting. Ways in which medical schools can do this are through case studies, problem-based learning sessions, and team-based learning sessions. Below is an example of a problem-based learning session that students in the Neuroscience and Behavior course at Indiana University School of Medicine (IUSM) complete.

Nadine is a 63 year old Caucasian female who presented to the emergency department due to an episode of confusion with a fever of 100.5F and a cough. It was determined by the emergency department that she suffered from delirium secondary to an atypical pneumonia and was admitted to rule out sepsis. Her delirium improved and she was released from the hospital shortly, but after continuing episodes of confusion her husband decided to bring her to their family physician. The family physician performed an MMSE and took additional labs, after which she was referred to a neurologist.

After further neuropsychological testing, the neurologist determined that Nadine was suffering from mild to moderate dementia, most likely due to Alzheimer's disease. The neurologist ruled out non-neurodegenerative disease processes by utilizing a careful history and physical examination skills along with MRI studies. He started Nadine on a standard Alzheimer's treatment regimen and instructed her to return every four to six months or if a significant neurological event occurs.

A few years later the neurologist is puzzled that Nadine has not experienced the steady neurodegeneration expected from an Alzheimer's patient. He reviews Nadine's chart and determines that she most likely suffers from vascular rather than Alzheimer's dementia. A FMRI confirms this diagnosis and the neurologist starts her on antiplatelet therapy. In addition, Nadine seems to be suffering from depression symptoms and she is started on an SSRI. Nadine's husband admits he is suffering from stress related to caretaking for Nadine and he agrees to seek support from Alzheimer's caretaker support groups and be evaluated by their family physician for depression symptoms.

This case is based on the natural disease history of Nadine of Pittsburgh, PA, including accurate and original laboratory, neurological, and imaging results. Release of information and permission to include her story in this PBL was obtained from her power of attorney. Supplemental materials and images were obtained through the Ruth Lilly Library medical library of the Indiana University School of Medicine.

For this case, students have a list of session objectives that must complete and understand during the duration of the case, including the following:

1. Become familiar with common etiologies and presentations of altered mental status in the elderly

2. Understand the basic history, physical exam, and laboratory work-up for an elderly patient presenting with altered mental status

3. Learn how to discriminate between normal aging processes, delirium, and dementia using the CAM and MMSE tools

4. Become familiar with common causes and treatments for delirium in the elderly

5. Describe the neuropsycological, biochemical, and neuroanatomy changes that occur in dementia

6. Become familiar with the natural history and treatment of Alzheimer's and vascular dementia

7. Understand the role psychiatric comorbidities and social circumstances can play in the treatment of a dementia patient

Additional ways to integrate basic science and clinical knowledge is to allow the students to interact with patients relatively early in their medical career (Cooke et al., 2010). It's important to not make students wait until their clerkship years to interact with patients. Rather, students need to begin patient interaction as soon as possible, so students can utilize their basic science knowledge in the real world and not just in a classroom setting. As this research is primarily about classroom-based education of medical students in their pre-clerkship years, the author does not delve deeper into this argument, other than to say it's important for students to understand their medical education is not solely in the classroom, but also out in the world interacting with real people.

Guideline 4.2: The medical curriculum should be spirally integrated.

Another guideline that pre-clerkship medical curricula should follow is to have a spirally-integrated curriculum. This is where there is a reintroduction of concepts at greater complexities throughout all levels of the medical curriculum. While this research is primarily about the pre-clerkship years of the medical program, in this guideline, years 3 and 4 (clerkship and elective years) are mentioned as well.

Ideally, medical programs will demonstrate how they can both horizontally and vertically integrate basic science courses, or more precisely put, how they can incorporate them into a spiral curriculum. The definitions for horizontal, vertical, and spiral integration are as follows (restated from Chapter 1, adapted from Brauer and Ferguson, 2015).

- **Horizontal integration** is referred to as integration across disciplines but only for a certain period of time. An example of this is combining the basic science courses together into one block during the first year of medical school.
- **Vertical integration** is integration across time, such as integrating anatomy into clerkships and electives within years 3 and 4 of medical school, rather than just having it in year 1.
- **Spiral integration** is a combination of horizontal and vertical integration. Here, basic and clinical sciences interact at all phases of medical school; they build upon each other

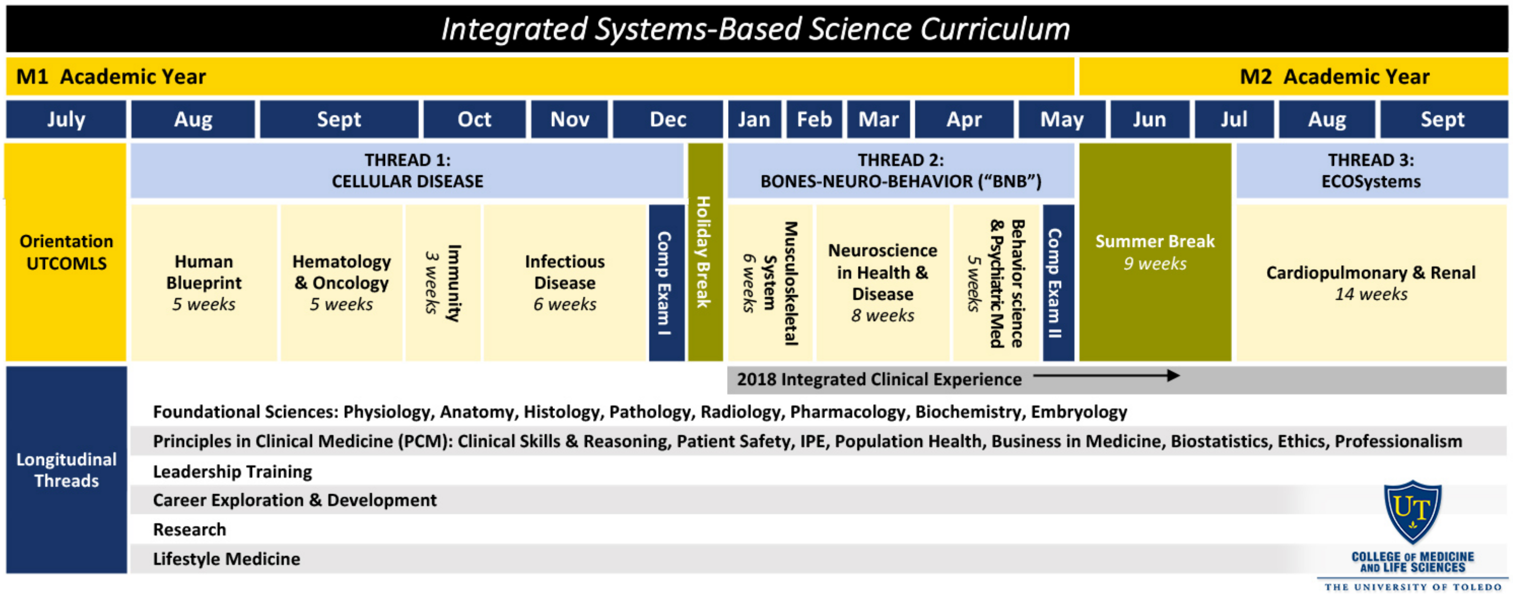
Many medical schools have demonstrated horizontal, vertical, and spiral integration with their basic science courses, according to curricular maps from their websites. While these three terms were not explicitly used in curricular descriptions on medical school websites, with only around 1-5% of medical schools using those terms, they were deemed to be important after looking specifically at curricular maps and how the basic science courses are organized within the medical curriculum. The following figures (4.8-4.10) model curricula for each specific integration type.

Vertical integration is displayed in Figure 4.8 from the University of Toledo College of Medicine and Life Sciences (2019). In this medical program, there are two types of vertical integration within the pre-clerkship years. One type is through the "threads" of topics such as Cellular Disease, Bones-Neuro-Behavior, ECOSystems, and

Cycles and Vices. Additional vertically-integrated foundational science “threads” include the disciplines of physiology, anatomy, histology, pathology, radiology, pharmacology, biochemistry, and embryology.

Additional ways in which medical schools incorporate vertical integration in their curriculum is through electives in the third and fourth years of the medical program. These specific electives are usually not shown on the curricular maps, generally being denoted as simply “Electives” on the curricular map. However, upon further examination of the curriculum on the web pages of the medical school, one can find more information on the electives. The University of Toledo College of Medicine and Life Sciences (2019), for instance, has an elective in the fourth year of the medical program entitled, “Clinical Anatomy.” In this elective, students have the opportunity to review information in a specific anatomical concentration (gross anatomy, microscopic anatomy, developmental anatomy, or neuroanatomy) by engaging in a self-directed learning opportunity of their choosing (and their clerkship director’s approval). This student opportunity in their elective years is a prime example of vertical integration in the medical curriculum.

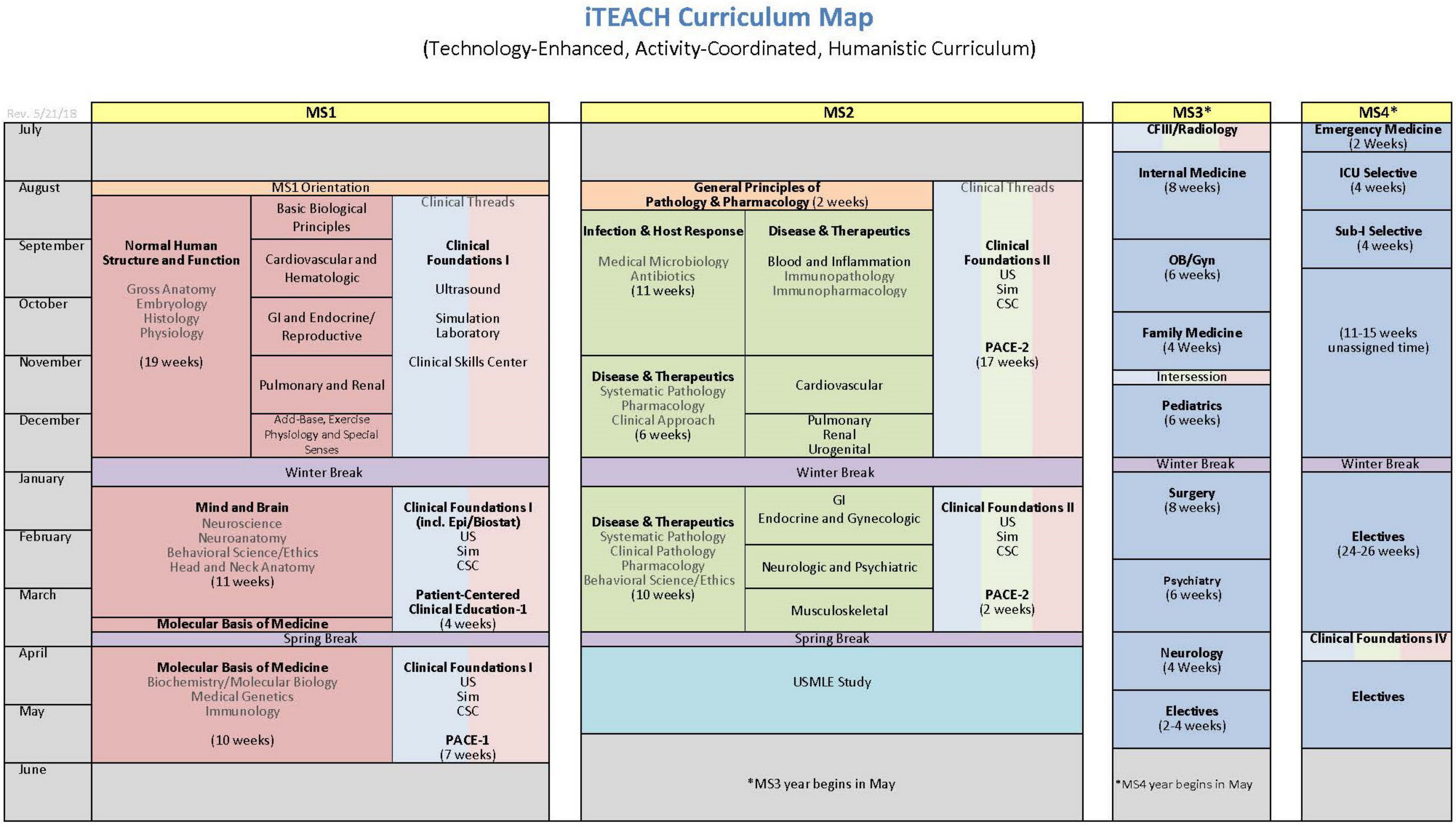
Figure 4.8: Demonstration of Vertical Integration at University of Toledo College of Medicine and Life



Horizontal integration is displayed in Figure 4.9 from the University of California-Irvine School of Medicine (2019). In this medical program, disciplines are integrated horizontally in a topic-based course for a set period of time. For example, in the Normal Human Structure and Function course, which runs from August-December in the first year of the medical program, gross anatomy, embryology, histology, and physiology are integrated together. In the Mind and Brain course which runs from January-mid March in the first year of the medical program, neuroscience, neuroanatomy, behavioral science and ethics, and head and neck anatomy are integrated together.

It should be noted when first looking at medical curricular maps, that horizontal and vertical integration can easily be confused with each other. A misconception may be that disciplines or "threads" spread across a map are horizontal integration, like in Figure 4.8. The foundational science courses in this map are even called "longitudinal threads" – easily confused with horizontal integration. We know from the definition above that integration across time, such as across all four years of the medical program at the University of Toledo College of Medicine and Life Sciences, is vertical integration. Likewise, with Figure 4.9: while the disciplines may look like they are vertically integrated from how the curricular map is displayed, this figure shows integration across disciplines, for a certain period of time, which is horizontal integration. In Figure 4.9, this horizontal integration is shown during the first semester of the first year of the curriculum at University of California-Irvine School of Medicine, when the anatomical sciences and physiology are integrated into the Normal Human Structure and Function course.

Figure 4.9: Demonstration of Horizontal Integration at University of California-Irvine School of Medicine

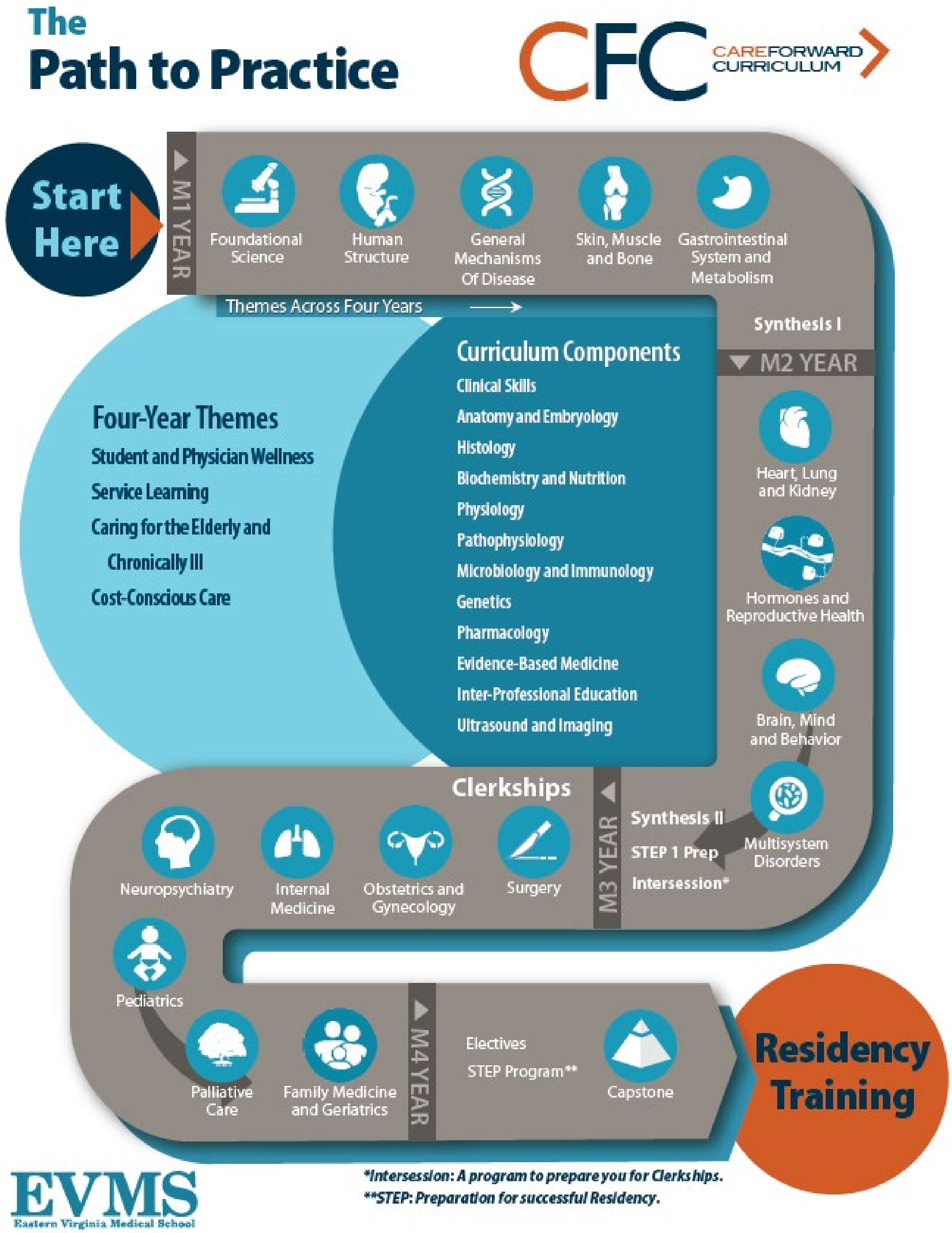


Additional confusions with the curricular maps presented here, and of those that exist from other medical schools, are the separation of the four years of the medical program. Specifically seen in Figure 4.9, there are white bars in between each of the years, showing a disconnect between each of the medical years. In order to have a cohesive medical curriculum, an ideal curricular map should show interconnectedness between all four years of the medical program, as is seen in Figure 4.10. This map shows how the four years of the medical program are not separate from each other, but that they interweave with one another.

Figure 4.10 shows an example of a spirally-integrated curriculum from Eastern Virginia Medical School (2019). This spiral curriculum utilizes horizontal integration from the courses, such as Human Structure, taught in the first part of the curriculum integrating gross anatomy, microscopic anatomy, and embryology. The curriculum also utilizes vertical integration both from the themes of Student and Physician Wellness; Service Learning; Caring for the Elderly and Chronically Ill; and Cost-Conscious Care spread throughout the four years. Additionally, spiral integration is also demonstrated by the use of technology in the classroom, including the use of ultrasound equipment during the basic science and clerkship years and longitudinal clinical cases from virtual families which simulate real-life clinical scenarios.

The curricular map from Figure 4.10 is presented in a way that shows how each year of the medical program is interconnected, with the ultimate goal of preparing the student for residency, utilizing all aspects of the medical curriculum. This curricular map is an exceptional example of how a medical should display their curriculum, and the author believes that more medical schools need to strive develop and show how their curriculum is connected throughout all four years of the medical program.

Figure 4.10: Demonstration of Spiral Curriculum at Eastern Virginia Medical School



A spiral curriculum aligns with LCME Standard 8.1: a medical school should have "coordinated and integrated content within and across academic periods of study (i.e., horizontal and vertical integration)" (LCME, 2018, pg. 22). While this standard does not explicitly explain or demonstrate how a medical school can implement this type of curriculum, it is assumed that a medical school should have some sort of representation of a spiral curriculum in order to receive accreditation or to become reaccredited. However, as is shown in the curricular maps above, not all medical schools are able to fully demonstrate spiral integration within their curricula. This may be a detriment to multiple groups of individuals who could benefit from seeing how a medical curriculum is organized, just by going to the medical school's website, including,

- Students interested in applying to the medical school trying to understand what courses they would take throughout their educational program
- Faculty at the medical school who want to know where and how they can incorporate a fourth-year anatomy dissection elective into the curriculum
- Educational researchers comparing curricula at different medical schools
- LCME survey team, to gain a better understanding about how specifically Standard 8.1 is implemented

Another example of an ideal curriculum map is one from Johns Hopkins University School of Medicine (2019), seen in Figure 4.11. This medical school's map is an interactive one, and while the interactivity of it cannot be easily demonstrated in this document, the author encourages her readers to go to Johns Hopkins' website to see how it is displayed. While this map may look complicated, its interactive capabilities allows the user to click on aspects of the map to learn more about the courses and features of the curriculum. For example, when one clicks on the Genes to Society of Week 1 on the map, a box shows up (Figure 4.11a) which displays more information about that week. When one clicks on the information symbol (the *i* button in the circle), another box pops up with information that particular aspect. Figure 4.11a shows more information about the Genes to Society course and even provides a link for the user to click on in order to go to that course's page.

The interactivity of the map allows for a very user-friendly interface, especially with allowing the user to have quick access to all aspects of the medical curriculum. In completing this part of the research, the author had difficulty at times accessing all the parts of a medical curriculum on the school's website because they were in such different places. Making a curricular map, and the parts of the curriculum that go with it, as interactive as possible for the user is an ideal way to display a curriculum.

Figure 4.11: Johns Hopkins University Curriculum Map

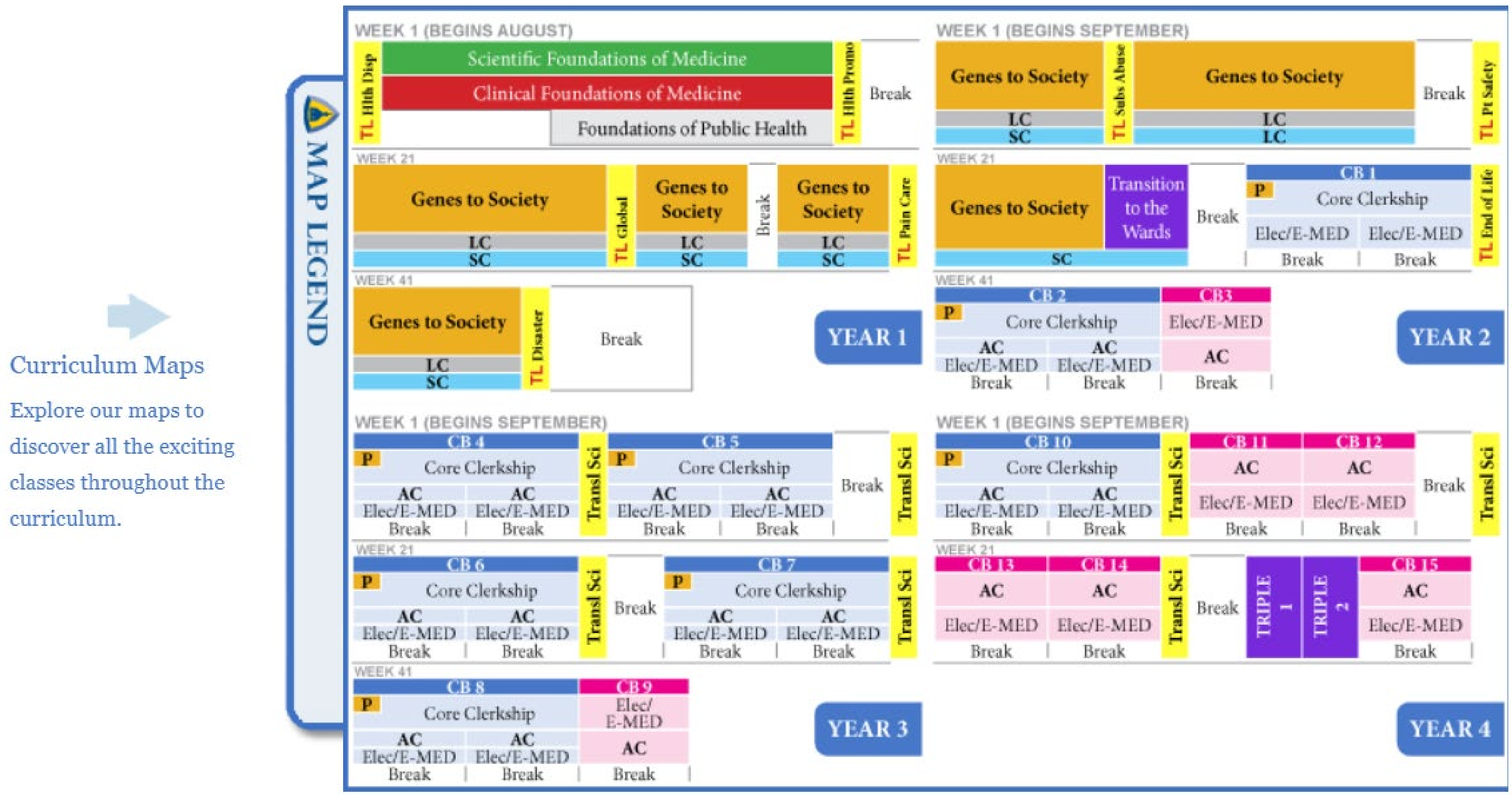
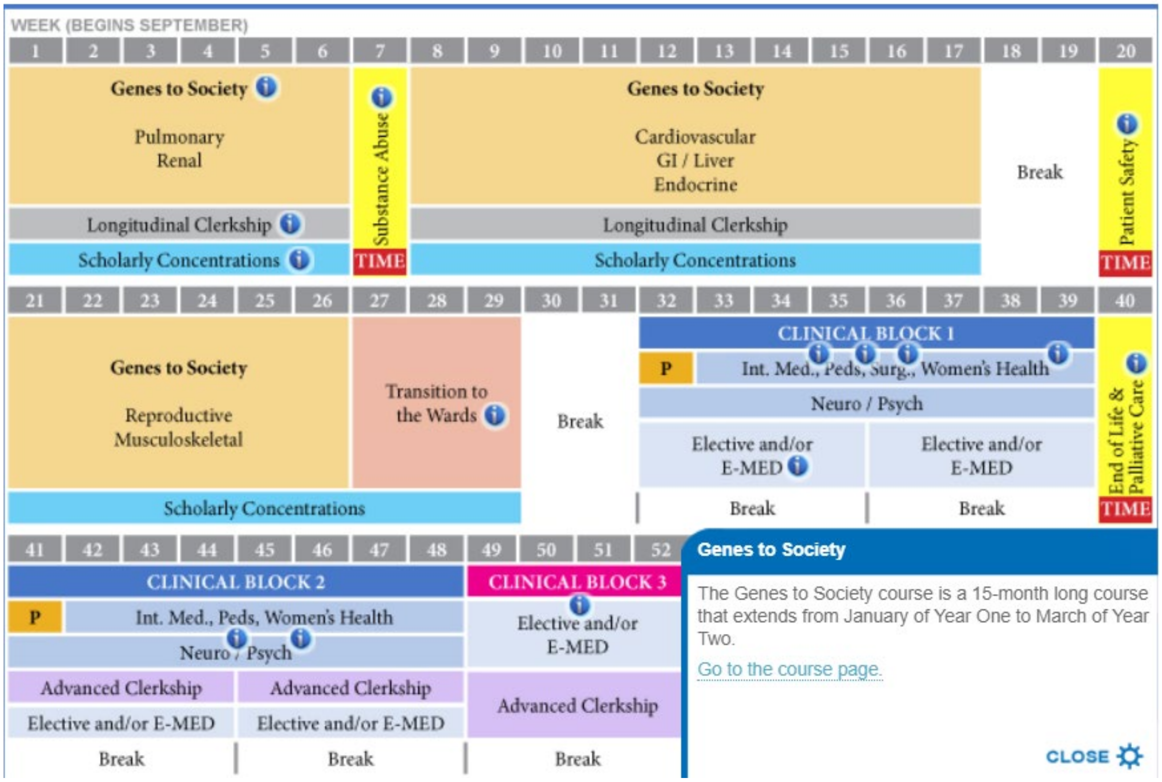


Figure 4.11a: Interactive Features of Johns Hopkins Curriculum Map



Guideline 4.3: Basic Science foundational courses should be taught in the beginning of the pre-clerkship medical curriculum, followed by organ systems-based blocks

The final guideline explains how content should be organized in a medical curriculum. Through the analysis of medical curricula, it was found that medical schools organize their content by topic-based courses with the same frequency as they organize by systems-based courses. However, further analysis showed that the most common way to organize the pre-clerkship curriculum was with one to two foundational science courses and the rest integrated systems-based courses. As per the LCME standards (2018): "The faculty of a medical school ensure that the medical curriculum includes content and clinical experiences related to each organ system…" (Standard 7.2, pg. 10). This statement from the LCME shows that it is a requirement for medical schools to organize their content around organ systems. However, the LCME does not explicitly say how much of the curriculum should be organized by systems. The author's recommendation is to not start right away with organ systems. Rather, medical schools should teach some foundational aspects of medical knowledge first, and then follow with organ systems-based units.

Students arrive at their first year of medical school with a wide variety of backgrounds. Some may have majored in the sciences, while others majored in the humanities (Cooke et al., 2010). Gross anatomy is not a required course for admittance into medical school (AAMC, 2019), and many students may have never seen a cadaver before. With these diverse student backgrounds, it is a commendable idea for medical programs to begin with foundational courses and then progress to systems-based courses. In these foundational courses, normal structure and function can be taught around the basic science courses, including the anatomical sciences, physiology, biochemistry, molecular biology, and genetics. These foundational sciences may be organized in a number of different manners, as evidenced by the data from this chapter. What is important, however, is that these disciplines are taught in way to provide an overview of normal structure and function prior to organ systems courses which most often describe abnormal structure and function.

Tying in with the other guidelines, both the foundational science courses and organ systems-based blocks should be organized within a spirally-integrated curriculum, by which material from the foundational sciences is reviewed when discussing the abnormal structure and function of various organ systems. This revisiting of basic science material is especially important for the anatomical sciences because, often, anatomical science information is taught only in the first semester of the medical program and not revisited again. It is important to have some review of normal anatomical science material prior to discussing the abnormal structure and function, so that students have a basic understanding the body as a whole.

Guideline 4.4: Active learning components should be incorporated throughout all courses in the medical curriculum

One of the other common terms used from medical school websites was "integration of learning modes," and these terms included such methods as team-based learning (TBL), problem-based learning (PBL), and case-based study. As mentioned above, these types of pedagogical methods can help integrate basic and clinical science information to the students by taking them through the steps of diagnosing a patient and understanding the diagnosis. Chapter 5 discusses what specific active learning components are used by anatomical science faculty in their courses.

Many medical schools restrict didactic lecture sessions to fewer than 50% of overall course time. The remaining course time is for active learning sessions, such as TBL and PBL, or for independent student learning (Cooke et al., 2010). These active learning sessions have mandatory attendance requirements at IUSM in the Human Structure course (IUSM-B, 2018-2019). This is in contrast with didactic sessions, where oftentimes attendance is not mandatory because those sessions are recorded for later viewing. From an AAMC survey (2017) sent out to medical students who had recently completed their second year, around 40% stated they rarely attended in-person lectures.

It's important for students to engage in small group, active learning sessions. Team-based learning, for example, combines out-of-class independent preparation for the session and in-class small group discussion. This type of active learning can foster both activation of prior knowledge and active knowledge construction in novel scenarios the students (Schmidt et al., 1989), encouraging problem-solving and critical thinking skills.

When these sessions are completed in a manner that encourages active student engagement and problem-solving skills, medical students enjoy the sessions (Vasan et al., 2009). However, as evidenced in the Indiana University School of Medicine-Bloomington (IUSM-B) first-year medical student surveys and focus group presented in Chapter 6, when faculty have no training in TBL delivery and there is minimal student engagement, students may have negative biases towards the active learning session. Additionally, for first-year medical students, they may not be accustomed to these small group sessions. In much of their college careers, the primary mode of content delivery was through didactic lectures. Upon entering medical school, students may only expect the continuation of these didactic lectures, so something new like a TBL or PBL may seem foreign to them. But, done correctly, these active learning strategies can foster problem solving skills, critical thinking skills, and lifelong learning skills (Sibley and Parmelee, 2008).

These guidelines discussed above show the vital components of a medical curriculum. While no medical school is exactly the same in the way the students are taught, there are a few important components to incorporate, including active learning methods, integration of basic and clinical sciences, spiral integration of the curriculum, and a focus on how the content is organized. In classifying or designing a medical curriculum, it is important to ask oneself if the curriculum encompasses these components shown in Figure 4.7. If the answer is no, then the curriculum must be scrutinized further. These points are further discussed in Chapter 7.

Final Thoughts Regarding Analysis of Curricula at US Allopathic Medical Schools

The data from US allopathic medical school websites show that there are many ways to not only integrate a medical curriculum but also to organize a medical curriculum. The general consensus from this chapter is that there is no one way to organize a medical curriculum. There are ideal starting points, however, such as having integration of basic and clinical sciences, integration at all levels of the medical curriculum, and having foundational courses in the beginning of the curriculum and then transitioning into organ systems-based blocks.

While this chapter has presented all of the ways in which a medical program can integrate and organize its courses, according to website data, there may be some discrepancies between what is said on the websites and what is actually done at the medical schools. Chapter 5 looks at how anatomical science faculty describe their medical curriculum. Additionally, the chapter delves into how specifically the anatomical science courses are organized into the curriculum and how those courses have changed due to curricular reform. Finally, anatomical science faculty perspectives on the curricular reform are presented through analysis of both surveys and interviews.

CHAPTER 5: RESEARCH AND ANALYSIS OF SURVEY AND INTERVIEW DATA FROM ANATOMICAL SCIENCE FACULTY

The analysis of web pages of allopathic medical schools in the United States is one way to understand the scope of curricular reform at medical institutions, but it may not provide all information desired. The verbiage on medical school websites may only be describing broadly how the curriculum is arranged, and the descriptions may not necessarily provide details about the curriculum or about potential negative aspects of the revision. Previous surveys of medical institutions have found that the anatomical sciences are being impacted by curricular reform, such as with decreased contact hours (McBride and Drake, 2018).

Since there is little information on the medical school websites regarding how specifically the anatomical science subjects have changed due to curricular reform, the author reached out to those individuals who were most directly immersed in and affected by the curriculum – the anatomy faculty who teach at those medical institutions. The author desired to get a more in-depth look on how the subjects of gross anatomy/embryology, microscopic anatomy, and neuroanatomy were organized into each medical curriculum. Additionally, it was desired to know how the faculty felt about the curriculum at their institution, and how this reform affected medical student education in the anatomic disciplines.

This chapter addresses the following research questions listed in Table 5.1 (see Chapter 3 for a discussion of the research hypothesis and rationale):

Table 5.1: Research Questions, Instruments, and Analysis for Chapter 5

Research Question	Data Collection Instruments	Type of Analysis
2a: What number of allopathic medical schools in the United States have undergone any major curricular reform within the last 10 years (since 2007)?	Faculty Survey (Appendix B)	Frequencies
2b. What were the medical schools' stated reasons for curricular reform at their institutions?	Faculty Survey (Appendix B) Faculty Interviews (Appendix C)	Frequencies Thematic analysis
3: How are anatomical science classes organized within medical school curricula that have been recently revised?		
3a: Does the anatomy content coverage increase, decrease or stay the same for classes involving the anatomical sciences?	Faculty Survey (Appendix B) Faculty Interviews (Appendix C)	Frequencies Chi square test of independence Content analysis Thematic analysis
3b. How does the curricular revision change the amount of lab experience and type of lab experience in the anatomical sciences?	Faculty Survey (Appendix B) Faculty Interviews (Appendix C)	Frequencies Spearman's correlation Content analysis Thematic analysis
3c. How does the curricular revision change the lecture experience in the anatomical sciences?	Faculty Survey (Appendix B) Faculty Interviews (Appendix C)	Frequencies Spearman's correlation Content analysis Thematic analysis
3d. What are faculty perceptions of curricular reform at their institution?	Faculty Survey (Appendix B) Faculty Interviews (Appendix C)	Frequencies Descriptive Statistics Spearman's correlation Chi square test of independence Mann-Whitney U Kruskal-Wallis Content analysis Thematic analysis

Methodology

This portion of the dissertation research analyzed data on how anatomical science disciplines were impacted by curricular reform at allopathic medical institutions. Additionally, this portion examined the perceptions of anatomical sciences medical school faculty about the medical curriculum in which they teach. The methodology was discussed in length in Chapter 3, and it is briefly reviewed here.

Survey of Allopathic US Medical School Faculty

The author created a survey which was distributed to faculty who teach in the anatomical sciences at allopathic medical schools in the United States. The questions from this survey may be seen in Appendix B. Questions from the faculty survey included both quantitative and qualitative, open ended questions. Some of the questions that were asked on the survey included the following:

- Questions about the general curriculum at the medical school, including whether the medical school had undergone curricular reform in the last 10 years, what were the main reasons for reform, if the faculty member had an involvement with the planning of the curricular reform, and how specifically the curriculum was changed due to the reform. Additionally, the faculty member answered what anatomical discipline courses they taught in. There are 12 of these questions with a mixture of quantitative (8) and qualitative open-ended questions (4).
- Questions pertaining to the three anatomical disciplines, such as how they are organized within the curriculum, what is included in the lab component, and how the number of hours and topics were changed due to reform. The number of questions that the respondent would answer varied depending on what they put as the

anatomical science discipline they taught. For instance, if they taught gross anatomy and microscopic anatomy, they would answer the same questions for each of those disciplines. There were 11 of these questions per discipline and they were a mixture of quantitative (9) and qualitative open-ended questions (2).

- Questions about perceptions of the curriculum, including five Likert scale questions where faculty would respond to a statement with strongly disagree, disagree, neutral, agree, or strongly agree. An example of a statement is "I am enjoying teaching within our school's curriculum." There was also one question on a 1-10 scale which asked about overall satisfaction with curriculum, with 1 = not at all pleased and 10 = extremely pleased.
- Open-ended questions about what faculty members like and dislike about the curriculum and any constructive suggestions they have to improve to curriculum. There were 3 of these questions.

The survey initially was distributed through SurveyMonkey (SurveyMonkey, Inc., 2017) beginning in October of 2017 by using purposeful sampling, expert sampling, and convenience sampling. Recruitment for this survey included posting a description and link to the survey on different professional societies' listservs, including American Association of Anatomists (AAA), Human Anatomy and Physiology (HAPS), American Association of Clinical Anatomists (AACA), DR-ED (an electronic discussion group for medical educators), and the Association of Anatomy, Cell Biology and Neurobiology Chairpersons (AACBNC). Additional recruitment for this survey included emailing faculty members known by the author, such as faculty at Indiana University School of Medicine Bloomington (IUSM-B) and faculty members that have graduated from Indiana

University's Anatomy Education program and who now teach at other schools. The author also emailed anatomy faculty who were members of AAA with available contact information in the membership directory. The survey closed in August 2018.

Quantitative Analysis of Survey Data

Data analysis of the survey commenced in August 2018, and survey data were compiled into a spreadsheet (Excel, 2016) and then analyzed using IBM Statistical Package for the Social Sciences (SPSS) Statistics Version 23 (IBM Corp., 2013). This quantitative data was analyzed by using descriptive statistics and frequencies to identify a general trend of the data.

For the other larger number of statistical measures performed, a Bonferroni correction was calculated for each. A Bonferroni correction is used to reduce the chance of a type I (false positive – when the null hypothesis is true, but it is rejected) error that may occur simply because there were large numbers of statistical tests performed. This correction takes account of the total number of statistical tests conducted and divides the normally used 0.05 significance value by the number of tests to get a new, more stringent significance (p) value (Field, 2013). The new significance values used for the data are explained in the results under *Variable Relationships* in this chapter.

A correlation matrix, using Spearman's correlation (denoted by r_s), was conducted to measure the linear relationship between two variables. As mentioned in Chapter 3, this test is a non-parametric test because the data in this research was found to violate the assumptions of normality. This test was completed for the interval data (see below). Interval data are continuous data which have equal intervals on a scale which represent equal differences in the variables (Field, 2013). The interval data from this survey that were analyzed with Spearman's correlations included,

- Faculty overall pleasure with curriculum (1-10 scale with 1 = not at all pleased and 10 = extremely pleased)
- Extent that gross anatomy, microscopic anatomy, and neuroanatomy lecture/lab changed due to curricular reform (1-5 scale with 1 = not at all and 5 = to a large extent)
- Extent of administration versus faculty involvement in curriculum (1-5 scale with 1 = entirely administration driven and 5 = entirely faculty driven)

These variables are considered interval variables because the numbers on the 1-5 scale were the variables entered into SPSS (IBM Corp., 2013) when the data analysis was being done.

The correlation coefficients from Spearman's correlation measurements are considered effect sizes (Field, 2013), and the strength of the correlations was interpreted based on recommendations by Mukaka (2012). These recommendations are seen in Table 3.5 in the Methodology chapter.

Additional statistical tests were performed to discover possible relationships among the data. In order to discover relationships among categorical (nominal) and ordinal variables, a Chi square test of independence (also referred to as Pearson chi square test) was completed. Categorical variables include those which are classified into categories. For example, from the faculty survey, in the question "Has your medical school undergone any major curricular reform in the last 10 years?" the responses to this question are either "yes" or "no." Those two responses are the categorical variables. Ordinal variables are categorical variables that are ordered in a certain way, but there is no set distance between the ordered variables, unlike interval data (Field, 2013). In this survey the Likert scale perception variables were considered ordinal data as opposed to interval data because the numbers (1-5) that aligned with the category (strongly disagree, strongly agree, etc.) were not seen by the faculty participants.

The following statements served as the Likert scale perception variables in this survey:

- I am enjoying teaching within our school's curriculum.
- I feel my students are getting adequate knowledge of Gross Anatomy in our school's curriculum.
- I feel my students are getting adequate knowledge of Microscopic Anatomy in our school's curriculum.
- I feel my students are getting adequate knowledge of Neuroanatomy in our school's curriculum.
- I feel like this medical program is producing adequately-trained medical doctors.

The following survey variables were compared with the Likert scale perception variables:

- Answering yes vs no on "Has your medical school undergone curricular reform in the last 10 years?"
- Amount of time since curricular reform was implemented
- Answering yes vs no on "Did you actively participate in the initial development process of the curricular reform?"
- How the anatomies are taught (stand-alone, combined with another discipline, part of a systems-based curriculum, other)
- How the amount of time in the anatomies changed (increased, decreased, stayed the same)
- How the number of topics in the anatomies changed (increased, decreased, stayed the same)

These variables were initially coded on a 1-5 scale with 1 = strongly disagree and 5 = strongly agree. However, for further data analysis, including the Chi square test of independence, the Mann-Whitney U test, and the Kruskal Wallis test, the data was converted from a 1-5 scale to a -2 to +2 scale (with strongly disagree equaling -2 and strongly agree equaling +2) upon the direction of the statistical consultant who worked with the author. This was done to more accurately reflect the positivity and negativity of the Likert statements.

Additionally, Cramer's *V* effect size was used to identify the strength of the association between the measured variables (if they showed statistically significant relationships) in a Chi-square test of independence. The magnitude of the effect size for Cramer's *V* is generally seen as values less than 0.5 have a small to medium effect and values greater than 0.5 have a large effect. Unlike correlation interpretations, however, there is no magnitude to these effect sizes. The interpretations based from recommendations by Field (2013) are seen in Table 5.2.

Table 5.2: Cramer's *V* Interpretation for Chi Square Test of Independence

Cramer's V Value	Magnitude of Effect Size
.00 – .10	Negligible
.10 –.30	Small
.30 – .50	Medium
>.50	Large

From Field, 2013

In order to discover differences in the faculty perceptions of the medical curriculum (the Likert scale perception variables from above) in those faculty whose medical school had undergone curricular reform versus those whose medical school had not undergone curricular reform, a Mann-Whitney U test was performed. This statistical test measures and compares the means of two groups, and it is a non-parametric test (Field, 2013). The Mann-Whitney U test compared means of the Likert perception variables above and the following two survey variables:

- Answering yes vs no on "Has your medical school undergone curricular reform in the last 10 years?"
- Answering yes vs no on "Did you actively participate in the initial development process of the curricular reform?"

Mean ranks were used in the Mann-Whitney U test, as opposed to means, which are normally viewed with parametric tests. This mean ranking system ranked the data from lowest to highest, irrespective of the group to which they belong. For example, any faculty member who answered more negatively to the Likert items (strongly disagree, for instance), were given a lower ranking number. Those who answered more positively (strongly agree) were assigned higher numbers. After the data was ranked, the ranks for the two groups were added, and the group with the higher mean rank was the group that showed more of a difference, with further analysis showing if it was a statistical difference (Field, 2013).

A Kruskal-Wallis statistical test was also run with the Likert perception data. This test measures the medians of more than two groups and is a non-parametric test. The analogous parametric test is a one-way ANOVA (analysis of variance) (Field, 2013). For this survey data, the Kruskal-Wallis test compared the medians of how the anatomical sciences were taught (stand-alone, combined with another discipline, systems-based, other) with Likert scale faculty perceptions data. For example, the author wanted to see if faculty enjoyed teaching in their medical curriculum more when the gross anatomy course was taught as a stand-alone course versus part of a systems-based course.

To discover the strength of the relationship between the variables above (if they showed significant relationships), effect sizes were found. For both the Mann-Whitney U and Kruskal-Wallis tests, the common measure of effect size is r (Field, 2013). In many calculations of effect sizes for the aforementioned statistical measures, r is negative, but, in most cases, the absolute value of r (referred to as $|r|$) is presented in the results. Table 5.3 displays the magnitude of effect sizes for r.

Table 5.3: *r* Interpretation for Mann-Whitney U and Kruskal-Wallis Statistical Tests

|*r*|	**Magnitude of Effect Size**
0.10	Small
0.30	Medium
0.50	Large

Qualitative Analysis of Survey Data

For the qualitative analysis of the open-ended survey questions, MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used with **content analysis** of the qualitative data, where sub codes and codes are developed from grouping the data together. Within content analysis, sub codes and codes can be tallied, so that there is a quantitative component within the qualitative analysis (Bengtsson, 2016). Initial sub codes and codes were generated with a **deductive content analysis** of the data, whereby **a priori codes** (first pass codes) were generated so that the author could focus on the more important curricular aspects that she wanted to research. For this research, the first pass codes which were generated from previous studies about medical curricular reform (see Chapter 2 under *20th Century Medical Curricular Models*).

After the first pass of the data, **inductive content analysis** was conducted. This approach is concerned with the generation of codes from the data itself, rather than starting with a theme or codes in mind (Bengtsson, 2016). This second pass of the data consisted of the codes and sub codes which were tallied.

The author first read through every answer to the question, and then she wrote down general patterns of the data, which may have been a code or sub code. If there were many similar patterns, then the author deemed them to be sub codes and created a general code for those similar sub codes. In order not to miss any codes or sub codes, the author then read through the data again and tried to find any additional terms that could be used in order to organize that data. Finally, after the author deemed the coding process completed, the number of codes and sub codes were tallied and are presented in this chapter along with select quotes from the student surveys. The student responses to the open-ended questions could be coded into more than one code or sub code, depending on the context of the response. Only the excerpt from the response that involved the specific sub-code or code was included within the tables found in this section. The codebook for the data may be seen in Appendix G.

Interviews of US Allopathic Medical School Faculty

The goal of the medical school faculty interviews was to gather additional data that followed up on trends seen from the survey data. Additionally, the author desired to gain insight into faculty perceptions on curricular reform at their medical schools that may not have come across fully in the survey responses.

Once US medical school faculty completed the survey, they had the option to agree to be included in a follow-up phone interview. The author sent the faculty members who agreed to a follow-up interview an email asking to schedule a phone interview. These interviews were semi-structured in that the author had a set list of questions to ask each interviewee, but at times the author would allow the conversation to deviate from topics that were not on the interview sheet. A list of interview questions may be found in Appendix C. Some of those questions included asking about what led to the need for curricular reform at their institution, how the course the faculty member teaches in changed due to curricular reform, how their students are doing now as a result of curricular reform, and what they think the point of curricular reform is. The interviews were conducted by telephone and were recorded using a digital recording device.

Transcription of the data was completed with the help of the Dragon NaturallySpeaking Software, Version 15 (Nuance Communications, 2018), and MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used to conduct a **thematic analysis** of the data. Thematic analysis is a type of qualitative analysis that involves searching for recurring ideas (or themes) in the data, after all data is collected. This type of analysis allows for a rich and deep understanding of the data to discover patterns and develop themes. This qualitative analysis also used deductive followed by inductive analysis, as was described above with content analysis. From similar codes, categories are made. From categories, themes are generated to capture a central idea from the data (Jason and Glenwick, 2016). The codebook for this analysis can be seen in Appendix H.

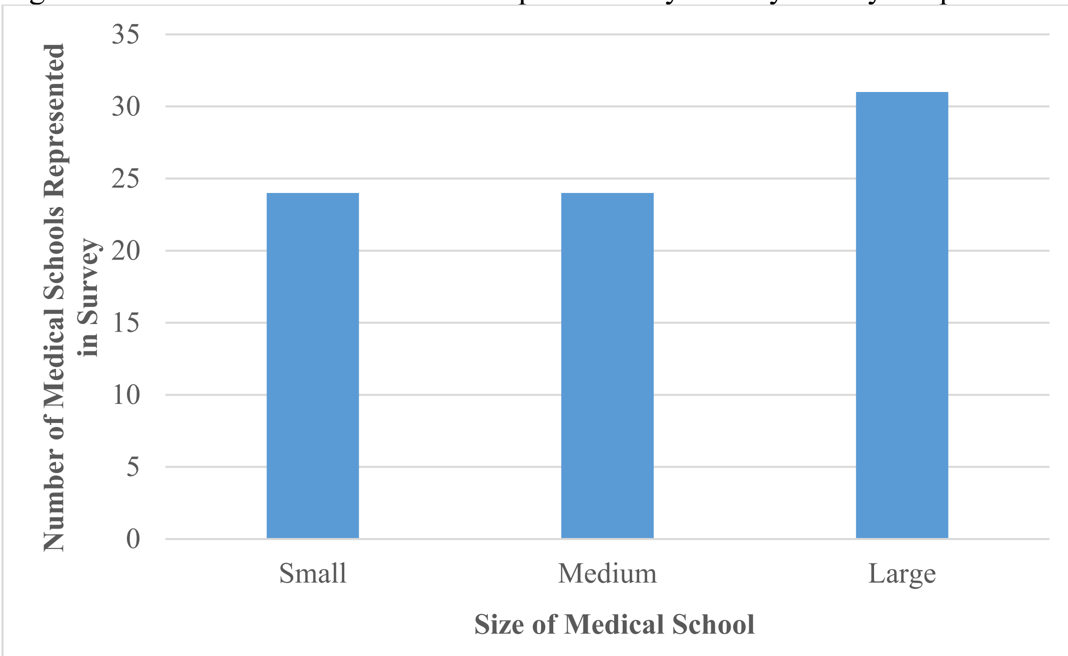
Quantitative Data Analysis of Survey

Demographic Data of Medical Institutions and Survey Respondents

Once survey responses were collected, the author examined the demographic data to see how medical schools were represented from respondents. In other words, were all geographic regions of the US represented from the survey respondents? Were some geographic areas or sizes of medical schools represented more than others? In total, there were 115 faculty members who responded to the survey from seventy-nine (79) different medical schools. Note that in some cases, more than one individual from the same medical school responded to the survey. For most of the analysis of survey data, all responses from all faculty respondents were used. However, solely for the count of medical schools represented in the survey, a medical school was only counted once, so as not to artificially inflate the demographic information. The 79 medical schools represented in this survey made up 54.5% of all allopathic medical programs (145) in the United States.

Figure 5.1 displays the number of medical schools represented in the survey, organized by size of the medical school (see Chapter 4 for explanation of how these medical schools were organized by their student enrollment). From this analysis, it was found that there were twenty-four (24; 50.0% of the 48 medical schools in this category) medical schools represented in the survey with a student enrollment fewer than 485 medical students (small-sized). There were twenty-four (24; 51.1% of the 47 medical schools) medical schools represented in the survey with a student enrollment between 485-725 medical students (medium-sized). There were thirty-one (31; 64.6% of the 48 medical schools) medical schools represented in the survey with a student enrollment of greater than 725 medical students (large sized). The small and medium-sized medical schools were almost equally represented; however, there were more large-sized medical schools which were represented from this survey. One reason for this is that large medical schools may have a better representation in the various areas the author sent recruitment notices, such as in the AAA listserv.

Figure 5.1: Sizes of Medical Schools Represented by Faculty Survey Respondents

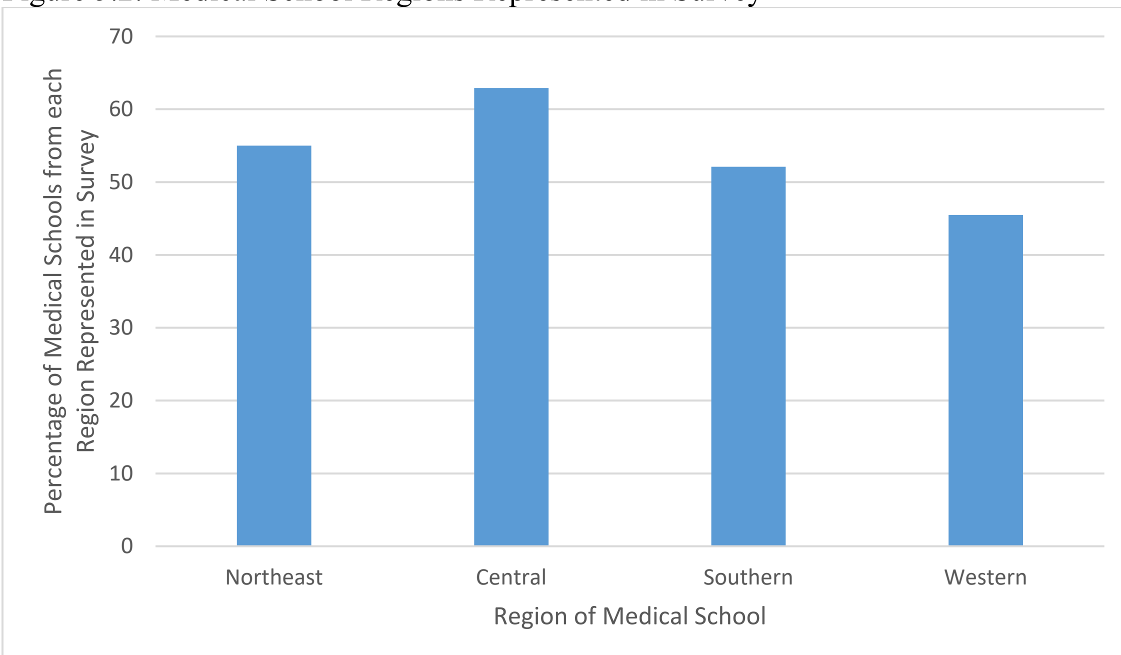


n = 79 total medical schools represented in survey

Small (< 485 medical students) and medium-sized (495-725) medical schools were almost equally represented from survey respondents; however, there were more large-sized (>725 medical students) medical schools which were represented from the survey.

In Figure 5.2, the percentage of medical schools from each region represented in the survey are displayed. The regional affiliation is based off data from the Association of American Medical Colleges (2018), and how that organization arranges medical schools by region. There were twenty-two (22) Northeast medical schools represented in the survey, which is 55% of all Northeast medical schools. The Central region contained twenty-two (22) of a representative sample from survey respondents, which is 62.9% of all Central region medical schools. From the Southern region, there were twenty-five (25) medical schools represented, which is 52.1% of all Southern region medical schools, and there were ten (10) medical schools in the survey from the Western region, which is 45.5% of all medical schools from the Western Region. In terms of number of medical schools participating in the survey, the Western region had fewer numbers compared to the other regions. Based on these percentages, medical schools from all US geographic regions had close to half of their medical schools participating in this survey.

Figure 5.2: Medical School Regions Represented in Survey



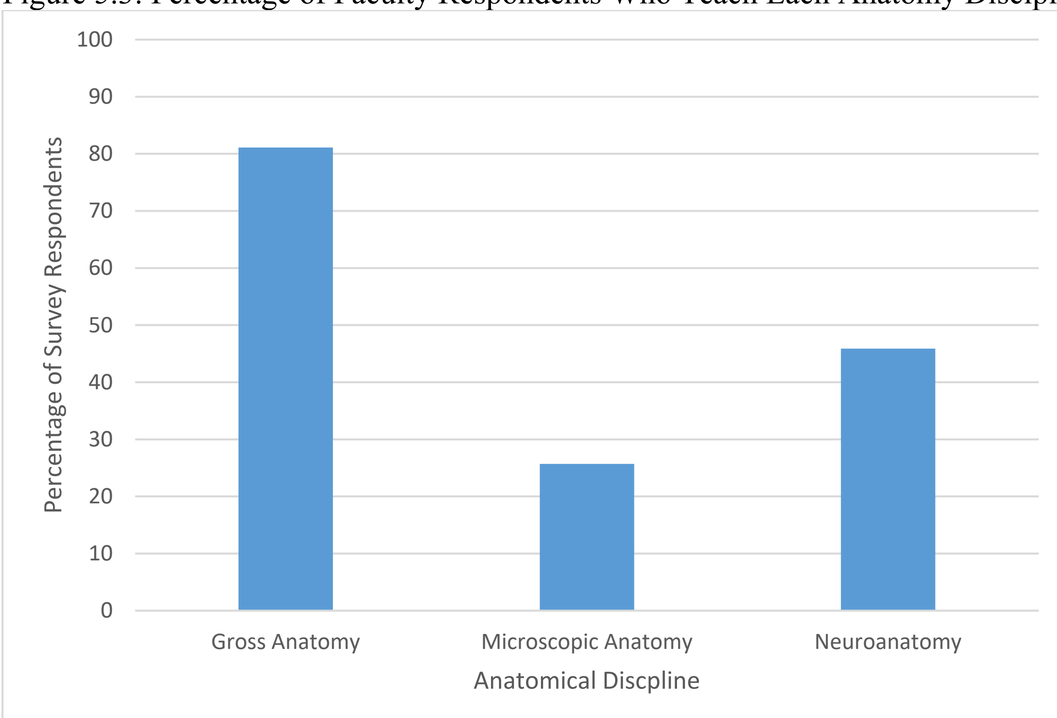
n = 79

Approximately half of all allopathic medical schools from each region in the United States were represented in the survey.

After reviewing which medical schools were represented in the survey, the author desired to know how many faculty from each anatomical discipline (gross anatomy, microscopic anatomy, and neuroanatomy) were represented. A caveat about this count is that only those individuals that marked "yes" to the question "Has your medical school undergone any major curricular reform in the last 10 years?" were able to mark which anatomical discipline(s) they taught. If an individual answered "no" to the above question, they skipped those questions that asked specific questions about the anatomical disciplines, because those questions focused only medical schools that had undergone curricular reform. In retrospect, this particular design of the survey was a limitation of this research, as complete demographic data was only collected from individuals at schools that had undergone recent curricular reform. Of the 115 faculty survey respondents, 95 stated their institution had undergone curricular reform within the last 10 years, and 74 of those 95 responded “yes” to at least one of the questions asking if they taught gross, microscopic, and neuroanatomy. The other 20 individuals who did not meet the criteria of responding “yes” about curricular reform and “yes” about teaching an anatomical science either taught another subject at their medical school or had another role all together, such as an administrator. In the recruitment process, it was asked of the respondents to take the survey if they taught gross, microscopic, and/or neuroanatomy at their medical institution, though it is possible that some of the survey respondents did not read the instructions carefully.

The percentage of survey respondents who taught in gross anatomy, microscopic anatomy, and neuroanatomy are displayed in Figure 5.3. Note that many of the respondents taught more than one anatomical discipline, so the total percentage was greater than 100. The most common anatomy discipline to teach was gross anatomy (60; or 81.1% of the 74 respondents), followed by neuroanatomy (34; 45.9%), and finally microscopic anatomy (19; 25.7%). Thirty-nine (39; 52.7% of the 74 respondents) faculty stated they only taught one anatomic discipline, while 35 respondents stated that they taught more than one anatomic discipline. Nineteen (19; 25.7% of the total 74 respondents) faculty taught both gross anatomy and neuroanatomy, nine (9; 12.2%) faculty taught both gross anatomy and microscopic anatomy, and two (2; 2.7%) taught both microscopic anatomy and neuroanatomy. Five (5; 6.8%) faculty members stated they taught all three anatomic disciplines. The majority of faculty surveyed taught gross anatomy, and this larger sample, compared to microscopic and neuroanatomy faculty, could be due to the areas of recruitment. Through the American Association of Anatomists and American Association of Clinical Anatomists, for example, many of the members of those societies may only teach gross anatomy. The author contacted the listserv of Association of Anatomy, Cell Biology and Neurobiology Chairpersons (AACBNC), but that recruitment measure did not reach as many individuals as the other measures did. This would be a limitation of this research.

Figure 5.3: Percentage of Faculty Respondents Who Teach Each Anatomy Discipline



n = 74 total faculty respondents

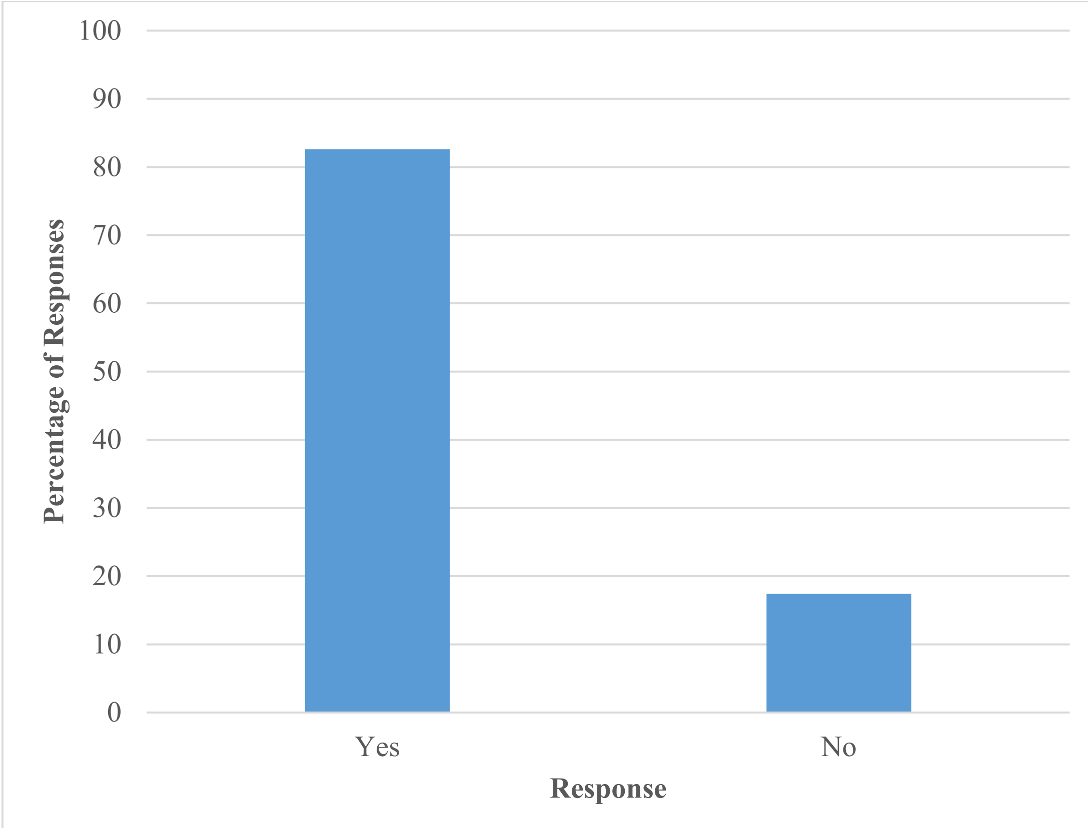
The majority of faculty respondents taught gross anatomy (81.1%), followed by neuroanatomy (45.9%), and then microscopic anatomy (25.7%).

This survey demographic data shows that there was representation from many medical schools across the nation. While it is difficult to have all 145 medical schools respond to the survey, the 79 institutions represented shows that there was general interest in the survey. There were more gross anatomy faculty who responded to the survey, compared to neuroanatomy and microscopic anatomy faculty. However, multiple respondents stated they taught in more than one discipline (and subsequently answered questions about their anatomical science courses in the revised medical curriculum), leading to more enrichment of the survey data.

General Medical Curriculum

One hundred and fifteen (115) faculty members responded to this survey. There were two qualifications for those faculty survey answers to be utilized in the analysis of the survey results: (1) the faculty had to state which medical school they worked at, and (2) the faculty had to answer "yes" or "no" to the first question of "Has your medical school undergone any major curricular reform in the last 10 years?" The rest of the survey did not require participants to answer every question in order to progress through the survey, and therefore, some respondents did not answer all questions. In fact, if the faculty member answered "no" to the question "Has your medical school undergone any major curricular reform in the last 10 years?", the skip logic of the online survey took them to the final questions asking about their perceptions of the curriculum at their institution. Figure 5.4 shows the distribution of the answers for the question "Has your medical school undergone any major curricular reform in the last 10 years?", with ninety-five (95; 82.6%) responding "yes" and twenty (20; 17.4%) responding "no."

Figure 5.4: Percentage of Faculty Whose Medical Schools Have Undergone Curricular Reform in Last 10 Years



n = 115

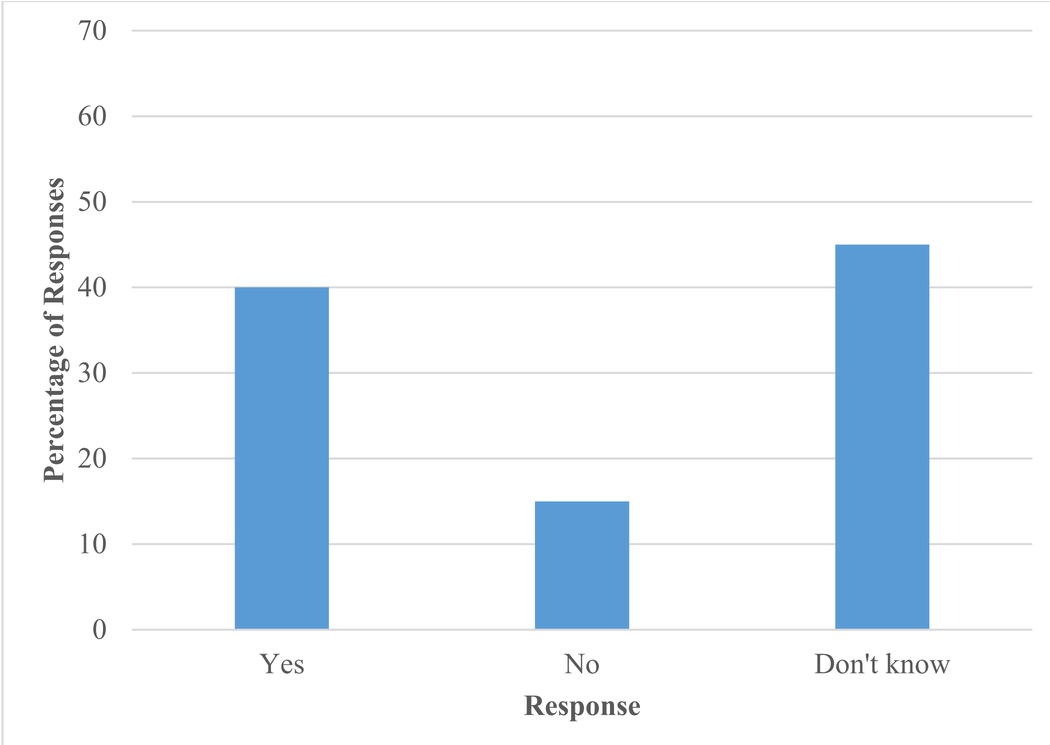
In response to the question, "Has your medical school undergone any major curricular reform in the last 10 years?" the majority of faculty survey respondents (82.6%) stated yes.

As seen in Figure 5.4, an overwhelming majority of medical schools have undergone curricular reform in the last 10 years, suggesting a dramatic change or paradigm shift in how medical schools are training their students. The rest of this chapter will present how and why this shift is occurring, with a further discussion of the way in which medical students are being trained in Chapter 7.

As stated above, there were seventy-nine (79) total medical schools represented in the survey. Of those 79 medical schools represented, sixty-seven (67) stated they had undergone curricular reform in the last 10 years, which accounted for 84.8% of the 79 medical schools represented – a number that was fairly consistent with the percentage of all faculty (82.6%) who responded to the survey and stated their medical school had undergone recent curricular reform. The 67 medical schools that stated they had undergone recent curricular reform represents 46.2% of all allopathic medical schools in the United States (145). In Chapter 4, 34.7% of medical programs stated they were either a new medical school or had a new curriculum in the last 10 years on their websites, a number that is lower than the 46.2% found here. However, there may be some medical programs that were not accurate with the timeline of their medical curriculum on their websites.

Of those respondents who said “no” to the question about recent curricular reform at their medical school, the next question on the survey asked these individuals, “Is your medical school planning to undergo any major curricular reform in the next 10 years?” Figure 5.5 shows the responses: most (9; 45.0%) stated they did not know. Eight (8; 40.0%) stated “yes,” and three (3; 15.0%) stated “no.” While the majority of respondents stated they did not know if their medical school was planning to undergo any curricular revision in the near future, the second most common response was that the medical school was planning to undergo the curricular reform in the near future, showing the trend of medical schools throughout the country undertaking a revision of their curriculum.

Figure 5.5: Percentage of Faculty Whose Medical Schools are Planning to Undergo Curricular Reform in the Next 10 Years

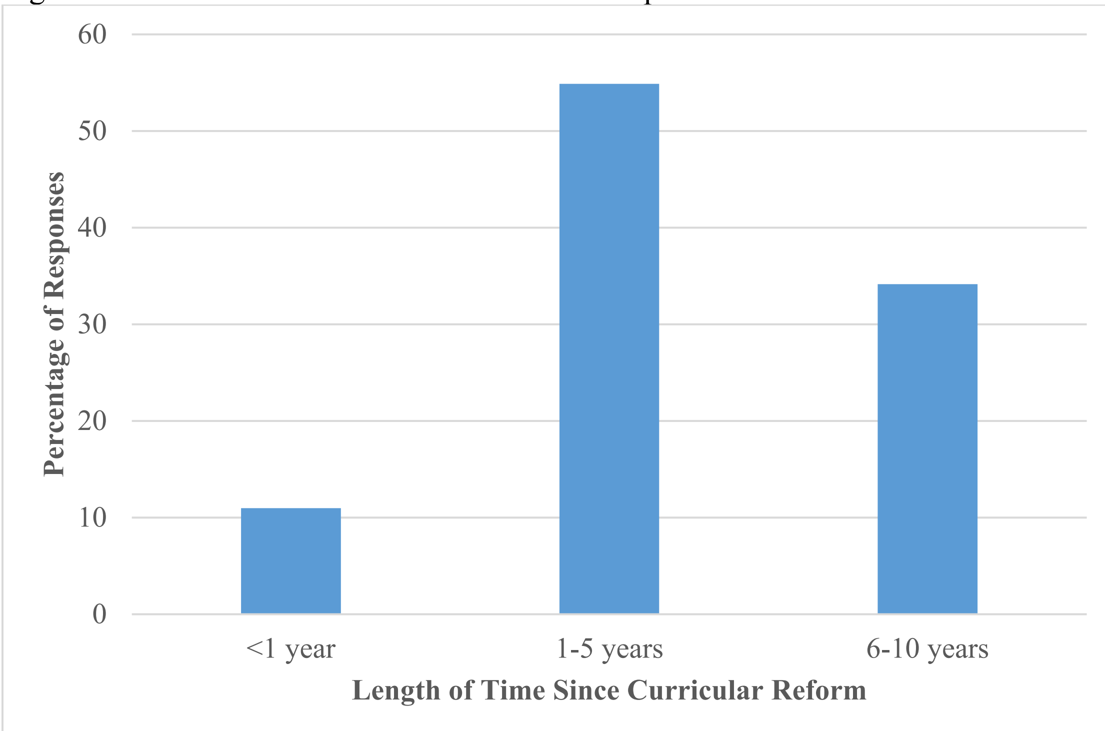


n = 20

The majority of faculty (45.0%) who said their medical school had not undergone curricular reform in the last 10 years stated they did not know if their medical school was planning on undergoing any curricular reform in the near future. However, 40% of faculty stated that their medical school was planning on undergoing curricular reform in the next 10 years.

When asked when the curricular reform was implemented, out of 82 respondents, nine (9; 11.0%) stated the new curriculum was implemented less than one year ago; forty-five (45; 54.9%) stated it was between one to five years ago; and twenty-eight (28; 34.1%) stated it was between six to ten years ago. The data set is displayed in Figure 5.6. Thus, 2/3 of medical programs that underwent curricular reform (65.9%) had this reform occur within the last five years (since 2013).

Figure 5.6: Time Since Curricular Reform was Implemented



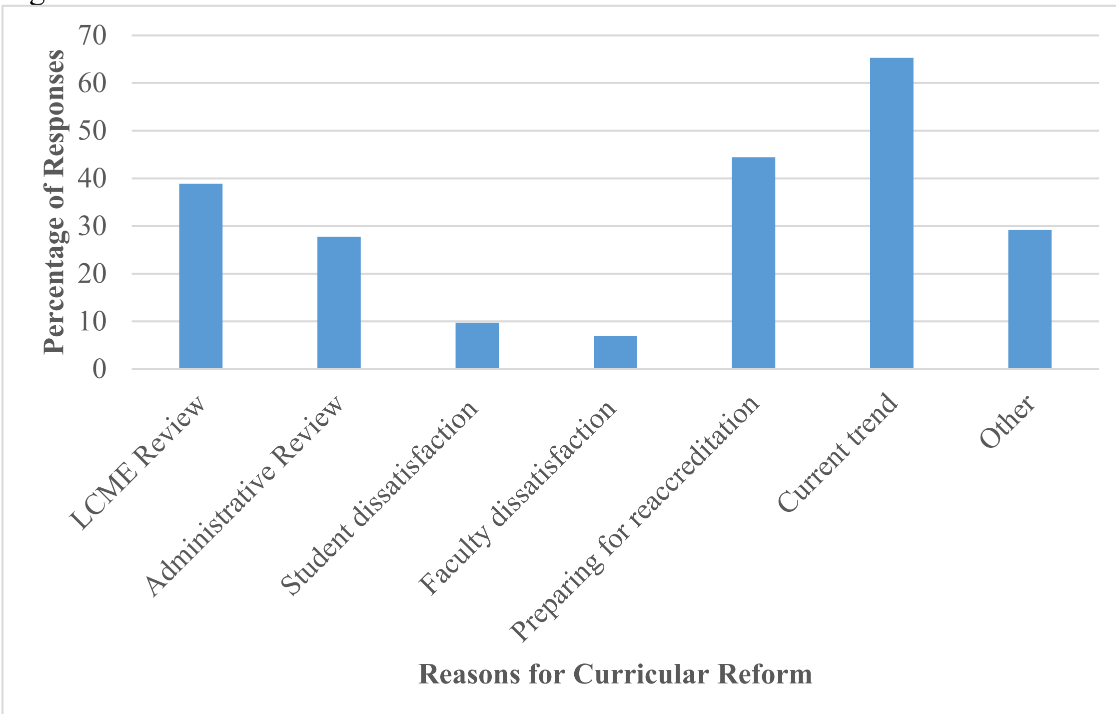
n = 82

In response to the survey question, “How long ago was the major curricular reform implemented?” 65.9% of the faculty stated their medical curriculum had undergone reform within the last five years.

When asked what were the reasons the medical school had undergone curricular reform, the faculty respondents (Figure 5.7), were able to select multiple possible reasons, so the total number of responses was greater than the number of respondents. Possible reasons on the survey included: LCME Review, Administration Review, Student dissatisfaction with the past curriculum, Faculty dissatisfaction with the past curriculum, Being proactive about LCME accreditation standards (preparing for re-accreditation), Keeping up with current trend of curricular reform, Don’t Know, and Other reasons. Of the 72 faculty who responded to this question, the most common reason for curricular reform was to keep up with the current trend (47; 65.3%), followed by preparing for reaccreditation (32; 44.4%), LCME review (28; 38.9%), administrative review (20;

27.8%), student dissatisfaction with the curriculum (7; 9.7%), and faculty dissatisfaction with the curriculum (5; 6.9%). Additionally, twenty-one (21; 29.2%) stated “other” as the reason. Some of these reasons included “It had been a long time (~20 years) since last curriculum reform, so we were due to evolve”; “Setting trends in medical curricula;” and “Enhancement of faculty knowledge about aspects of the curriculum in which they did not actively teach.” With the most common response of “keeping up with the current trend,” faculty are stating their medical schools are observing what other medical programs are doing, in regard to the curriculum, and do not want to be left behind. Additionally, with the LCME strongly recommending medical schools to integrate their curricula (LCME, 2018), that serves as an impetus for medical schools to take a closer look at their curricula and revise it to align with LCME standards. Many research studies have cited both keeping up with the current trend and LCME accreditation as reasons their medical school had undergone curricular reform (Heiman et al., 2018; Klement et al., 2017).

Figure 5.7: Reasons for Curricular Reform

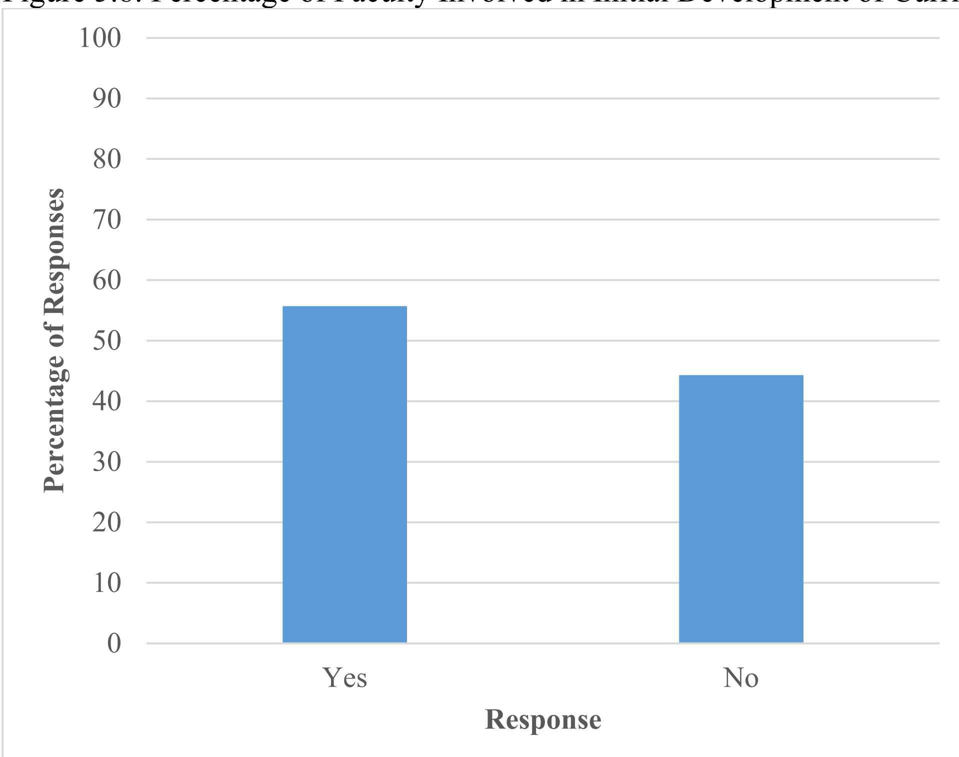


n = 72

In response to the survey question, "What were the reasons for curricular reform?" the most common reason was to keep up with the current trend of other medical programs undergoing curricular reform. Preparing for LCME reaccreditation, and LCME review were also common responses to this survey question. Faculty were able to choose as many reasons listed (or supply their own reasons) as applied to their medical institution.

The author desired to know how many faculty were actively involved in the development of the most recent curricular reform. While "actively" was not specifically defined in the survey, it was the thought that administration who purposefully asked for faculty input about the curriculum or faculty who joined curriculum committees would be considered to have participated in the curricular reform. Of the seventy-nine (79) respondents of this question, forty-four (44; 55.7%) stated they were actively involved with the reform (yes), and thirty-five (35; 44.3%) stated they were not involved (no). The data set is displayed in Figure 5.8. Additionally, the author desired to know to what extent the curricular reform involved faculty members assisting with it. Figure 5.9 shows the number of respondents (total of 76) that stated if the curricular reform at their institution was driven more by faculty (7; 9.2%), equally by faculty and administration (22; 28.9%), or more by administration (39; 51.3% for some administration and 8; 10.5% for entirely administration driven). Interestingly, none of the curricular reform was driven entirely by the faculty.

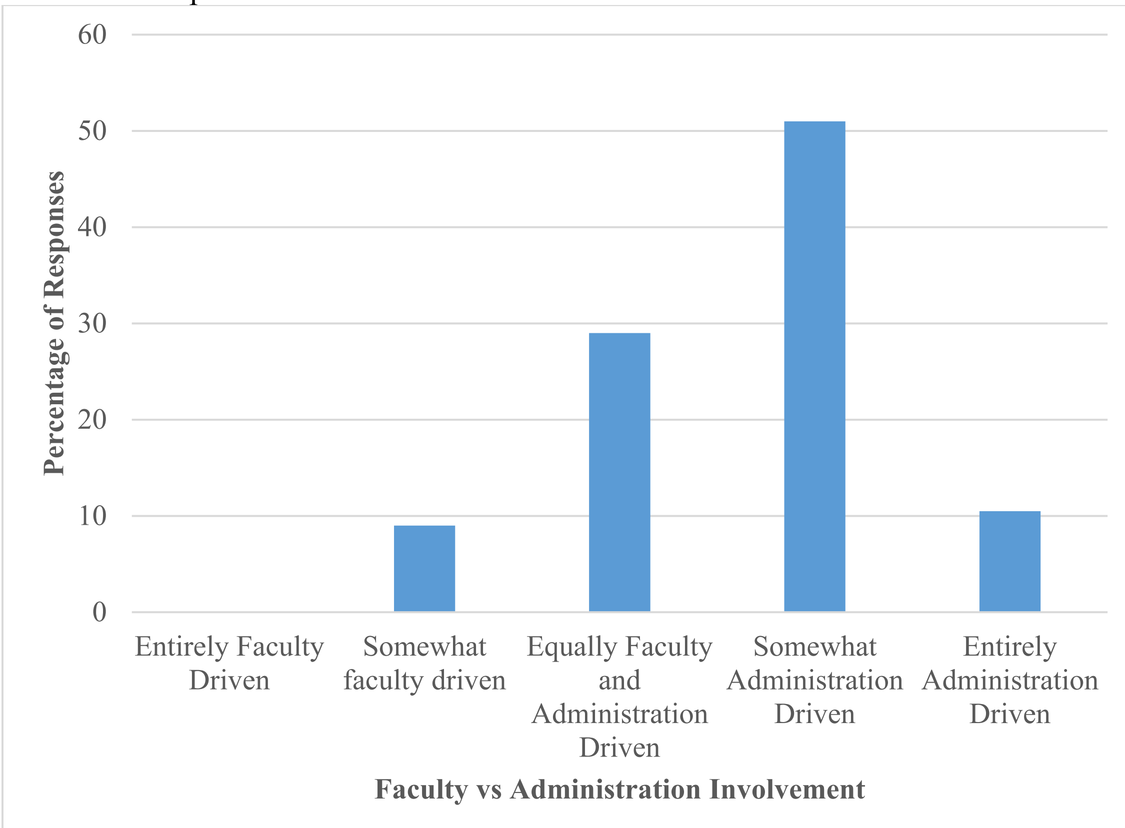
Figure 5.8: Percentage of Faculty Involved in Initial Development of Curricular Reform



n = 79

In response to the question, “Did you actively participate in the initial development process of the curricular reform?” the majority of faculty (55.7%) stated yes.

Figure 5.9: Extent of Administration and Faculty Involvement in Curricular Reform Implementation



n = 76

In response to the survey question, "To what extent was your curricular reform faculty versus administration driven?" the majority of faculty (61.8%) stated that their curricular reform was driven either somewhat or entirely by the administration, though close to 30% stated there was equal faculty and administration input into the curricular reform. No faculty stated their curricular reform was driven primarily by their faculty.

Most of the survey respondents stated their medical school had undergone curricular reform in the last ten years, and 40% of those who stated their medical school had not undergone curricular reform, said their medical schools is planning to undergo curricular reform within the next decade. These data show that curricular reform is a very common occurrence at medical schools in the United States, and this revision is not stopping any time soon – especially with the trend of medical schools modeling their curricula off each other, to keep up with the current trend of curricular reform. However, the development of revised medical curricula is primarily driven by the administration, which may lead to more negative feelings of the curriculum by faculty who teach in it, something that will be discussed further on in this chapter.

Anatomical Sciences within the Revised Medical Curricula

For the specific anatomical disciplines studied (gross anatomy, microscopic anatomy, and neuroanatomy) the faculty were asked how those disciplines were organized within the revised/reformed medical curriculum. As a reminder, this question was only asked of those faculty whose medical school had undergone curricular reform in the last ten years. For all three disciplines, with results displayed in Figure 5.10, the most common way to organize each of the anatomical sciences was within a systems-based course: for gross anatomy, this was twenty-eight (28; 45.9% of the 61 faculty responses; for microscopic anatomy this was six (6; 54.5% of the 11 faculty responses; and for neuroanatomy, this was thirteen (13; 81.3% of 16 total responses).

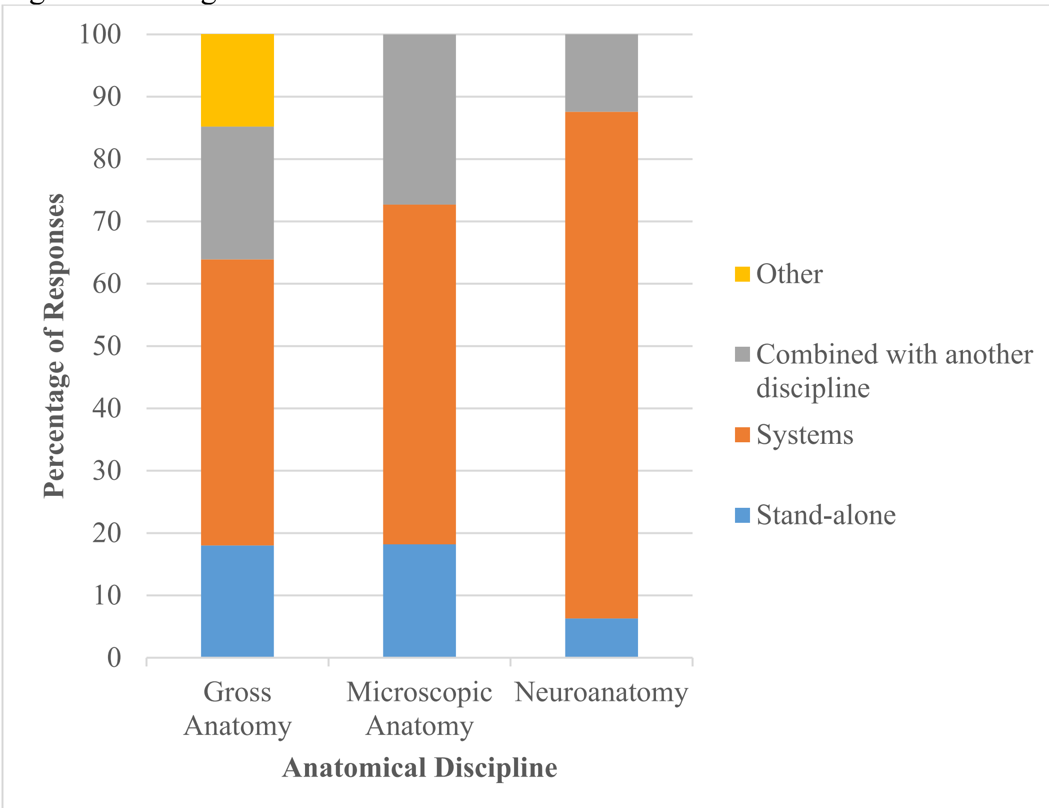
Having the anatomical science courses combined with another course was the second most common way to organize those subjects (gross anatomy 13 responses, 23.3% of the 61 total responses; microscopic anatomy 3 responses, 27.3% of 11 total responses; neuroanatomy 2 responses, 12.5% of 16 total). While having the anatomical science courses organized within a systems-based course or combined with another course were the more common ways to organize these subjects, some medical schools that had undergone curricular reform in the last ten years still had some or all of these subjects taught as separate disciplines (gross anatomy 11 responses, 18.0%; of the 61 total; microscopic anatomy 2 responses, 18.2% of the 11 total; neuroanatomy 1 response, 6.3% of the 16 total).

Additionally, there were nine (9; 14.8% of the 61 total) responses from gross anatomy faculty who stated gross anatomy was organized in a different way than any of the responses listed above. One of the ways which did not fit into another category was described by the University of Miami Leonard M. Miller School of Medicine as "The MD track has an 8-week stand-alone course with embryology and histology. The MD / MPH track has a longitudinal course that spans three 'Fundamentals of Basic Sciences' courses over a 6 - 7-month period." Another "other" response from Stony Brook University School of Medicine stated:

> "A little more complex perhaps than the choices. The Clinical Anatomy and Physiology courses incorporates gross anatomy, radiographic anatomy, histology, embryology, neuroanatomy, and physiology as a first semester systems/region hybrid. Later neuroanatomy is covered in greater depth as part of the nervous system block and histology and physiology are incorporated into the other systems courses."

These data about how the anatomical sciences were organized in the medical curriculum show that the majority of schools integrated one or more of the anatomical sciences with other topics. While the method of integration may vary (integrated with another course or splitting up the course's topics throughout a systems-based curriculum), the trend was that the anatomy disciplines tend to be integrated in some way, versus being stand-alone courses. These data confirm what was found previously by surveys of anatomical science course directors (McBride and Drake, 2018), that the most common way to organize the anatomical sciences was either through systems-based courses or as part of an integrated course. These results are also confirmed by research from medical institutions that have revised their own curricula around organ systems (Brooks et al., 2015; Heiman et al., 2018; Klement et al., 2017).

Figure 5.10: Organization of Anatomical Sciences in the Medical Curriculum



n = 61 for gross anatomy, 11 for microscopic anatomy, and 16 for neuroanatomy

In a revised curricula, all of the anatomical disciplines are most commonly organized into organ systems-based courses. Neuroanatomy, in particular, is organized into organ systems courses more often than the other two anatomy disciplines. Combined with another discipline: combined with one or more course, such as histology, biochemistry, physiology; Systems: organ systems-based course, such as Cardiovascular or Gastrointestinal; Stand-alone: discipline is taught by itself.

The next question on the survey asked about pedagogical techniques used in the anatomy course. The faculty were first asked what types of pedagogical methods they used, and then they were asked approximately what percentage of the didactic course time for each of the anatomical disciplines they taught was devoted to those pedagogical methods. The meaning of course time was for the entire course – not just one class period time. So, for example, one class period may have utilized only a traditional lecture, but another class period may have utilized a combination of a lecture and TBL session. The faculty were asked to think about the average amount of time of the entire course devoted to the pedagogical method. If an anatomical discipline was taught in multiple courses, then the faculty was told to think about the different pedagogical methods used in each of those courses. The types of pedagogical techniques listed included the following:

- Traditional lectures
- Team-based learning (TBL)
- Problem-based learning (PBL)
- Flipped classroom experience
- Pre-recorded lectures
- Discussion groups
- Case-based study

This question was asked for each discipline, as the author recognized that different anatomical disciplines may be taught with different pedagogical methods. In addition, this question focused on the lecture (or didactic) portion of each anatomic course, as opposed to any lab component of the course. A separate question later in the survey specifically asked about what learning tools were used in the lab portion of each anatomical discipline.

The results for this survey question are displayed in Table 5.4. For the overall number of faculty utilizing a certain pedagogical method, the most common type to use in the classroom was traditional lectures. In gross anatomy, 51 out of 59 respondents stated they had traditional lectures (86.4%); in microscopic anatomy, 10 out of 11 respondents used it (91%); and in neuroanatomy, 14 out of 16 faculty respondents used it (87.5%). Traditional lectures were also the pedagogical method used during the majority of course time, especially for microscopic anatomy-related topics. 96.7% of class time in microscopic anatomy was devoted to traditional lectures, while the percentage of class time in gross anatomy was 51.7% and 49.9% for neuroanatomy.

The other pedagogical methods used in the anatomical disciplines did not follow a similar pattern of common use for each discipline, so they will be presented in descending order (second most common to seventh most common) by the anatomical discipline. For gross anatomy, the second most commonly used pedagogical method was pre-recorded lectures, with 37 of 59 (62.7%) faculty stating they used it in their course, for an average of 21.9% of course time devoted to it. The next most common method was TBL, with 31 of 59 (52.5%) faculty using it, for an average of 23.1% of course time. This was followed by case-based study, with 27 of 59 (45.8%) faculty using it, for an average of 15% of course time. The next most common was a tie with PBL and flipped classroom experience with 22 of 59 (37.3%) using it. More time in the gross anatomy course was devoted to flipped classrooms (18.7%) than PBL (16.5%). The least common pedagogical method used in the gross anatomy course was discussion groups, with only 13 of 59 (22%) of faculty utilizing it, for an average of 11.9% of course time.

For microscopic anatomy, after traditional lectures, the most common pedagogical method used was a five-way tie with PBL, TBL, flipped classroom, pre-recorded lectures and discussion groups (2 of 11 faculty, 18.2%). However, more microscopic anatomy course time was devoted to pre-recorded lectures (45%) than PBL (12.5%), and the other three pedagogical methods (5% for each of them). Finally, no faculty stated they used case-based study in their microscopic anatomy course.

For neuroanatomy, the second most common pedagogical method was a tie between TBL and case-based study with 9 of 16 faculty (56.3%) using it. Case-based study was used in slightly more percentage of course time (13.8%) than TBL (13.1%). The next most common was PBL, with 8 of 16 faculty using it (50%) for an average of

28.3% of course time. The next most common was pre-recorded lectures, used by 7 of 16 faculty (43.8%) for an average of 25% of course time. The two least used pedagogical methods in neuroanatomy were discussion groups (6 of 16, average of 11.7% of course time) and flipped classrooms (5 of 16 faculty, average of 13.0% of course time).

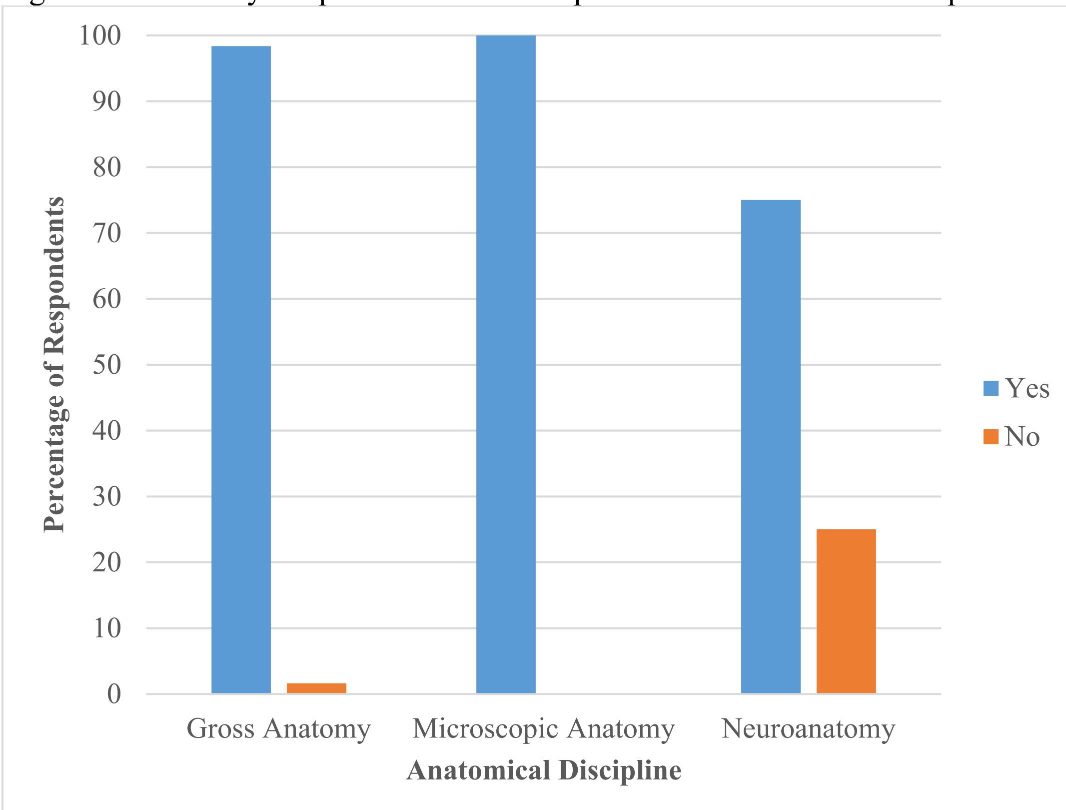
These data show that traditional lectures were still the reigning method to deliver basic science content in the anatomical sciences, in terms of number of faculty using it in their course, and percentage of course time devoted to it. However, the data also show how a variety of other methods – non-didactic, or active learning strategies – were used in the medical classroom.

Table 5.4: Pedagogical Methods Used in Teaching Didactic Portion of each Anatomical Discipline

Anatomical Discipline	**Gross Anatomy**		**Microscopic Anatomy**		**Neuroanatomy**	
Pedagogical Method	# of faculty using it (%)	Average % of course devoted to this pedagogical method	# of faculty using it (%)	Average % of course devoted to this pedagogical method	# of faculty using it (%)	Average %of course devoted to this pedagogical method
Lecture	51 (86.4%)	51.7%	10 (91%)	96.7%	14 (87.5%)	49.9%
TBL	31 (52.5%)	23.1%	2 (18.2%)	5.0%	9 (56.3%)	13.1%
PBL	21 (35.6%)	16.5%	2 (18.2%)	12.5%	8 (50%)	35.7%
Flipped Classroom	21 (35.6%)	18.7%	2 (18.2%)	5.0%	5 (31.3%)	13.0%
Pre-recorded Lectures	37 (62.7%)	21.9%	2 (18.2%)	45.0%	7 (43.8%)	25%
Discussion Groups	13 (22.0%)	11.9%	2 (18.2%)	5.0%	6 (37.5%)	11.7%
Case-based study	27 (45.8%)	15%	0 (0%)	0.0%	9 (56.3%)	13.8%
Sample size (n)	59		11		16	

The next question on the survey asked the respondents if there was a lab experience in the anatomical science course in which they taught. The faculty had they option to respond “yes” or “no” to that question. Results for that question are seen in Figure 5.11. All but one faculty member (60 out of 61, 98.4%) who taught gross anatomy stated there was a lab experience in that course. All microscopic anatomy faculty (12, 100%) stated there was a lab experience. Neuroanatomy was the only discipline that had multiple respondents say there was no lab experience in that course – 12 of 16 (75%) said “yes” to the lab experience, while 4 stated “no” (25%). These data show that, despite curricular reform changing the way in which the anatomical sciences are taught, lab experiences were still included with the didactic portions of most anatomical science courses.

Figure 5.11: Faculty Response about Lab Experience in Anatomical Discipline



n = 61 for gross anatomy, 12 for microscopic anatomy, and 16 for neuroanatomy

Most faculty stated their anatomical discipline in which they taught had a lab component. However, 4 of the 16 neuroanatomy faculty stated their neuroanatomy course did not have a lab experience.

The next question about the lab component of the anatomical disciplines referred to the types of teaching tools and methods used in each lab. The list of choices for the gross anatomy lab included the following:

- Student-led dissection of cadavers
- Student-led dissection of animals (e.g., cats)
- Teacher-led demonstrations on prosections (previously dissected cadavers)
- Peer teaching
- 2D printed images from an atlas or textbook (e.g., Thieme Atlas)
- Computerized modules (e.g., online cadaver demonstration such as AnatomyPal or Anatomy and Physiology Revealed)
- 3D computer models of anatomical structures (e.g., Anatomage Table)
- Anatomy-in-clay models
- Virtual microscopic slides

- Optical microscopic slides
- Bones
- Models
- Medical imaging (e.g., CTs, MRIs, X-rays)
- Interactive ultrasound demonstrations
- Other (please describe)

The respondents were able to choose all experiences that were used in the lab. For gross anatomy, a total of fifty-seven (57) respondents answered this question. Despite a concern in the literature about the future of cadaver dissection (Wilson et al., 2018), survey responses showed that some of the most common pedagogical tools used in the gross anatomy lab were some form of cadaver dissection or use of prosection. Specifically, 52 of 57 faculty (91.2%) stated they use cadaver dissection in their lab, and 37 of 57 (64.9%) used prosections. This data set can be seen in Table 5.5.

In the order from most commonly used to least commonly used in the gross anatomy lab, medical imaging was most common with 53 of 57 faculty (93%) using it. The number of faculty using this tool was actually slightly greater than the total number using cadaver dissection (91.2%). Use of bones in the lab was also very common, with 52 faculty (91.2%) using that method. Models were commonly used as well, with 46 faculty (80.7%) using that tool. Prosections and peer teaching were the next most common methods, with 38 faculty each using them (66.7%).

From there, the numbers of faculty using certain tools in the laboratory dropped off slightly. Only 30 of 57 faculty (52.6%) used 2D images from a textbook in the gross anatomy lab. Twenty-three (23) of 57 (40.4%) used computerized modules. Seventeen (17; 29.8%) faculty used virtual microscopy; thirteen (13; 22.8%) used 3D computer models. Optical microscopy was still in use by some medical programs, with 4 faculty (7%) stating they used that method. Three (3; 5.3%) faculty used anatomy in clay models, and only faculty stated they used dissection of animals in the lab. Finally, four (4; 7%) stated they used “other” components in their lab. These other components included “oral presentations of dissections” and laproscopic/robotic/traditional surgical procedures.”

After looking at the general trend of how gross anatomy was incorporated into the curriculum and what tools were used in the laboratory, it was found that, more often, interactive ultrasound demonstrations were incorporated into a systems-based gross anatomy course, than when gross anatomy was only combined with another discipline or a stand-alone course. Research by Bahner et al. (2013) showed how ultrasound could be integrated into a curriculum, both through vertical integration, during all four years in a medical program, but also through horizontal integration in second year organ systems-based courses.

A general trend was also found when looking at how gross anatomy was incorporated into the curriculum and what programs used medical imaging. It was more common for both systems-based and topic-based (combined with another discipline) gross anatomy courses to integrate medical imaging into the curriculum than it was for medical programs that taught the anatomical sciences as stand-alone courses. Research by Orsbon et al. (2013) found that physicians place high importance on medical students learning radiology in the pre-clerkship anatomy classroom.

Table 5.5: Laboratory Methods used in Teaching Gross Anatomy

Lab Component	# of faculty who use it (%) n = 57
Medical imaging (e.g., CTs, MRIs, X-rays)	53 (93%)
Student-led dissection of cadavers	52 (91.2%)
Bones	52 (91.2%)
Models	46 (80.7%)
Teacher-led demonstrations on prosections (previously dissected cadavers)	38 (66.7%)

Peer teaching	38 (66.7%)
Interactive ultrasound demonstrations	35 (61.4%)
2D printed images from an atlas or textbook (e.g., Thieme Atlas)	30 (52.6%)
Computerized modules (e.g., online cadaver demonstration such as AnatomyPal or Anatomy and Physiology Revealed)	23 (40.4%)
Virtual Microscopy	17 (29.8%)
3D computer models of anatomical structures (e.g., Anatomage Table)	13 (22.8%)
Optical Microscopy	4 (7.0%)
Other	4 (7.0%)
Anatomy- in-clay models	3 (5.3%)
Student-led dissection of animals (e.g., cats)	1 (1.8%)

This next list of choices was for the microscopic anatomy lab and included the following:

- Virtual microscopic slides
- Optical microscopic slides
- Peer teaching
- 2D images from text books
- Other (please describe)

These data can be seen in Table 5.6. Virtual microscopy was the most common laboratory method used in teaching microscopy anatomy with 11 of 12 faculty (91.7%) utilizing it in their lab. Only one (1; 8.3%) medical program used optical microscopy, confirming what is seen in the literature – that medical programs are transitioning to a more user-friendly interface of virtual microscopy (Wilson et al., 2016).

Other laboratory methods used in teaching microscopic anatomy included 2D images from the textbook (4 or 12 faculty, 33.3%), peer teaching (3; 25%), and “other” (3; 25%). Some of the other type of lab components included “case presentations” and “self-directed modules.”

Trends for type of microscopic anatomy lab component taught in microscopic anatomy curriculum were not sought for two reasons: one, the sample overall of microscopic anatomy faculty was small and two, because most medical programs (91.7%) stated they used virtual microscopy, so that would not show any trend with the way that microscopic anatomy was organized in the medical curriculum.

Table 5.6: Laboratory Methods used in Teaching Microscopic Anatomy

Lab Component	# of faculty who use it (%) n = 12
Virtual Microscopy	11 (91.7%)
2D images from text books	4 (33.3%)
Peer Teaching	3 (25%)
Other	3 (25%)
Optical Microscopy	1 (8.3%)

The following list of methods were choices on the survey question about what laboratory methods are used in teaching neuroanatomy:

- Student-led dissection of cadavers
- Student-led dissection of animals (e.g., cats)
- Teacher-led demonstrations on prosections (previously dissected cadavers)
- Peer teaching
- Preserved cross sections of brains
- 2D images from an atlas or text book
- Computerized modules (e.g., online cadaver demonstration such as AnatomyPal or Anatomy and Physiology Revealed)
- 3D computer models of anatomical structures (e.g., Anatomage Table)
- Anatomy- in-clay models
- Virtual microscopic slides
- Optical microscopic slides
- Bones
- Models
- Medical imaging (e.g., CTs, MRIs, X-rays)
- Other (please describe)

For neuroanatomy, the most common lab tools used were preserved cross sections of brains (10 of 11; 91%), followed by 2D images and medical imaging (8 each; 72.7%).

This was followed by prosections and peer teaching (6 each; 54.5%), and then models (5; 45.5%). Cadaver dissections and computerized modules were the next most common with 4 of 11 faculty using those tools each (36.4%), followed by virtual microscopy and bones (3 each; 27.3%), and then finally animal dissections and 3D computer modules (2 out of 11 for each method; 18.2%). No medical programs used anatomy-in-clay models, optical microscopy, or any other methods in the neuroanatomy lab. These data are seen in Table 5.7.

There was a general trend found in medical programs that taught neuroanatomy as part of a systems-based course having medical imaging as a lab component in teaching neuroanatomy. This also demonstrates the importance of including radiological imaging within the anatomical sciences curriculum.

Table 5.7: Laboratory Methods used in Teaching Neuroanatomy

Lab Component	# of faculty who use it (%) n = 11
Preserved cross sections of brains	10 (91%)
2D printed images from an atlas or textbook (e.g., Thieme Atlas)	8 (72.7%)
Medical imaging (e.g., CTs, MRIs, X-rays)	8 (72.7%)
Teacher-led demonstrations on prosections (previously dissected cadavers)	6 (54.5%)
Peer teaching	6 (54.5%)
Models	5 (45.5%)
Student-led dissection of cadavers	4 (36.4%)
Computerized modules (e.g., online cadaver demonstration such as AnatomyPal or Anatomy and Physiology Revealed)	4 (36.4%)
Virtual Microscopy	3 (27.3%)
Bones	3 (27.3%)
Student-led dissection of animals (e.g., cats)	2 (18.2%)
3D computer models of anatomical structures (e.g., Anatomage Table)	2 (18.2%)

Anatomy- in-clay models	0
Optical Microscopy	0
Other	0

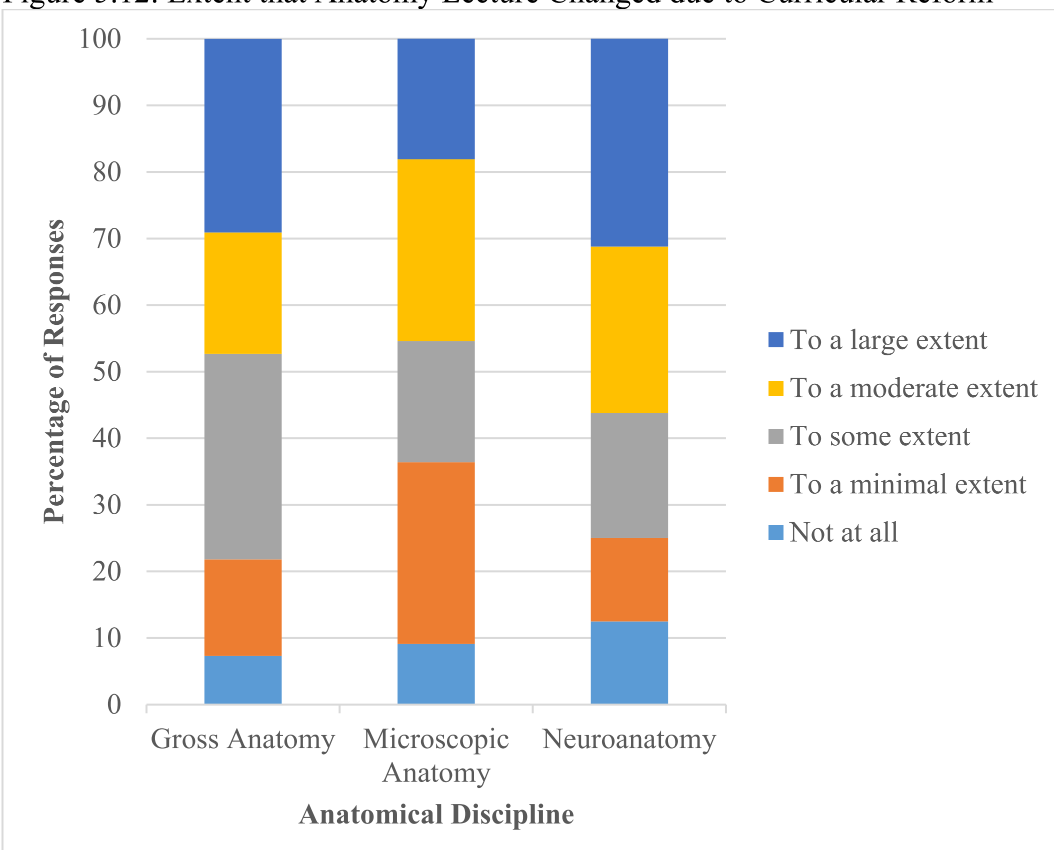
The next question on the survey asked the faculty member to what extent the lecture and lab experience changed in the anatomical sciences due to curricular reform. The respondents could pick from the options below:

- Not at all (1 on the sliding scale)
- To a minimal extent (2)
- To some extent (3)
- To a moderate extent (4)
- To a large extent (5)

Lecture data is presented in Figure 5.12, and lab data is presented in Figure 5.13. For gross anatomy, 16 of 55 faculty (29.1%) stated lecture changed to a large extent; 10 of 55 (18.2%) stated it changed to a moderate extent; 17 (30.9%) said to some extent; 8 (14.5%) said to a minimal extent; and 4 (7.3%) stated that gross anatomy lecture did not change at all. For microscopic anatomy, 2 of 11 faculty (18.2%) stated lecture changed to a large extent; 3 of 11 (27.3%) stated it changed to a moderate extent; 2 (18.2%) stated it changed to some extent; 3 (27.3%) stated it changed to a minimal extent; and only 1 out of 11 faculty (9.1%) stated microscopic anatomy lecture did not change at all due to curricular reform. For neuroanatomy, 5 of 16 faculty (31.3%) stated lecture changed to a large extent; 4 of 16 (25%) stated it changed to a moderate extent; 3 (18.8%) stated it changed to some extent; 2 (12.5%) stated it changed to a minimal extent; and 2 of 16 faculty (12.5%) stated neuroanatomy lecture did not change at all.

Overall, between 45-55% of faculty respondents in each discipline stated that the anatomic discipline *lecture* components changed from a moderate to a large extent. In contrast, 20-35% of faculty in each discipline stated there were minimal or nonexistent changes in lecture. These data show that in all three anatomical disciplines, that curricular reform has changed the lecture in some fashion. Please see Tables 5.13-5.15 below under the Qualitative Data Analysis of Faculty Survey section of this chapter for an explanation of some specific ways the lecture portion in each of the anatomical disciplines have changed due to curricular reform.

Figure 5.12: Extent that Anatomy Lecture Changed due to Curricular Reform



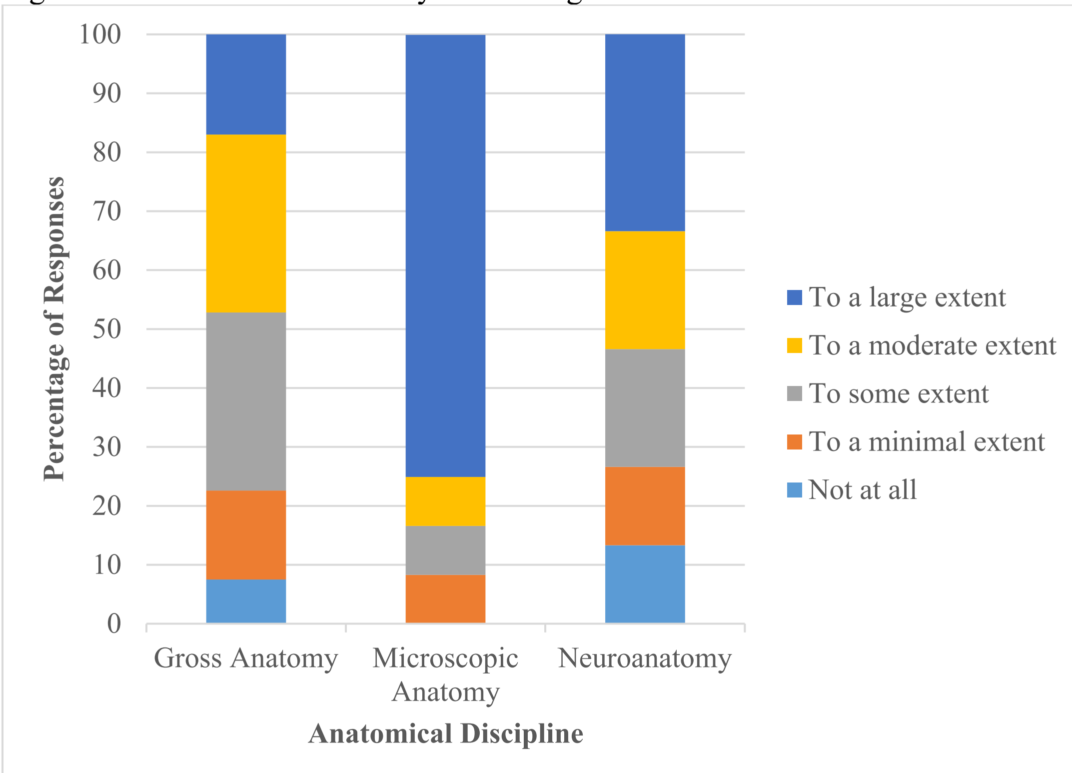
n = 55 for gross anatomy, 11 microscopic anatomy, and 16 neuroanatomy

In response to the survey question, “To what extent has the [specific anatomical discipline] lecture changed due to curricular reform”, over half of the faculty from each anatomical discipline stated that the lecture changed from a moderate to great extent, while less than 40% stated it changed only minimally or not at all.

For gross anatomy lab, 9 of 53 faculty (17.0%) stated the lab changed to a large extent; 16 of 53 (30.2%) stated it changed to a moderate extent; 16 (30.2%) stated it changed to some extent; 8 (15.1%) stated it changed to a minimal extent; and 4 of 53 faculty (7.5%) stated gross anatomy lab did not change at all. For microscopic anatomy lab, 9 of 12 faculty (75%) stated lab changed to a large extent; only 1 faculty (8.3%) each stated microscopic anatomy lab changed to a moderate extent, to some extent, and to a minimal extent. No microscopic anatomy faculty stated that their lab did not change at all. For neuroanatomy lab, 5 of 15 faculty (33.3%) stated their lab changed to a large extent; 3 of 15 (20%) stated it changed to a moderate extent; 3 (20%) stated it changed to some extent; 2 (13.3%) stated it changed to a minimal extent; and 2 of 15 neuroanatomy faculty (13.3%) stated the lab did not change at all.

Overall, it was found that neuroanatomy and microscopic anatomy labs changed to a much greater extent than the gross anatomy lab. Almost 85% of microscopic anatomy faculty and 73% of neuroanatomy faculty stated the lab changed from a moderate to large extent, compared to only 47% of gross anatomy. Table 5.12-5.14 found under the Qualitative Data Analysis of Faculty Survey section of this chapter displays explanations of some specific ways the lab portion in each of the anatomical disciplines have changed due to curricular reform.

Figure 5.13: Extent that Anatomy Lab Changed due to Curricular Reform



n = 53 for gross anatomy, 12 microscopic anatomy, and 15 neuroanatomy

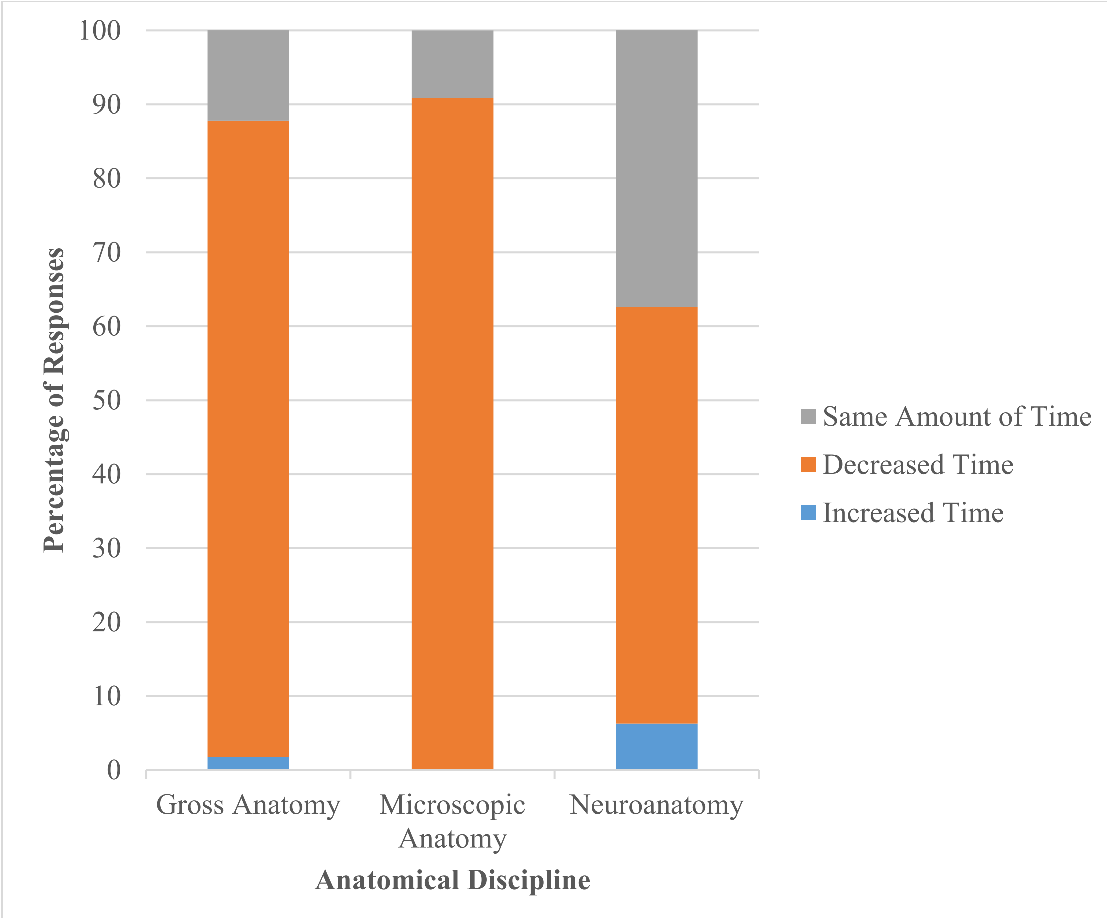
For the survey question that asked, "To what extent has the [specific anatomical discipline] lab experience changed since your school has undergone curricular reform?" most microscopic anatomy faculty (75%) stated their lab changed to a large extent. The majority of neuroanatomy faculty (53.3%) also stated their lab changed from a moderate to large extent. Gross anatomy faculty were less likely to say their lab changed drastically due to curricular reform.

The next question on the survey asked the respondents about how the *amount of time of instruction* and the *number of topics* within the anatomical disciplines changed due to curricular reform. Respondents had the option of choosing whether the amount of time of instruction *increased, decreased,* or *stayed the same* after curricular reform. This question was not specific to either the lecture or lab experiences related to the anatomical disciplines – faculty were to think of the entire discipline and how the amount of time and number of topics changed due to curricular reform. Data from these questions are displayed in Figures 5.14 and 5.15.

For the change in amount of time of instruction in gross anatomy due to curricular reform, 49 of 57 faculty (86.0%) stated time decreased, while 7 of 57 (12.3%) stated there was no change (stayed the same), and only 1 faculty (1.7%) stated there was an increase in time. For microscopic anatomy, 10 of 11 faculty (90.9%) said there was a decrease in time, while only 1 (9.1%) stated the amount of time stayed the same after curricular reform. For neuroanatomy, 9 of 16 (56.3%) faculty stated the amount of time decreased, 6 of 16 (37.5%) stated it stayed the same, and 1 faculty (6.3%) stated there was an increase in time after curricular reform.

The majority of faculty from each of the anatomical disciplines stated there was an overall decrease in amount of time in their discipline. These data support other research about the declining amount of course hours dedicated to the anatomical sciences in recent years (Drake et al., 2014; McBride and Drake, 2018). McBride and Drake (2018) stated how gross anatomy and microscopic anatomy hours have changed more drastically, compared to neuroanatomy course hours, which was also seen from the data, where 43.8% of faculty stated there was either no change or even an increase in amount of time dedicated to teaching neuroanatomy. The specific amount of time that was changed due to curricular reform was not quantified in this research, and that limitation will be discussed in Chapter 7.

Figure 5.14: Change in Amount of Time Dedicated to Teaching Anatomical Disciplines due to Curricular Reform



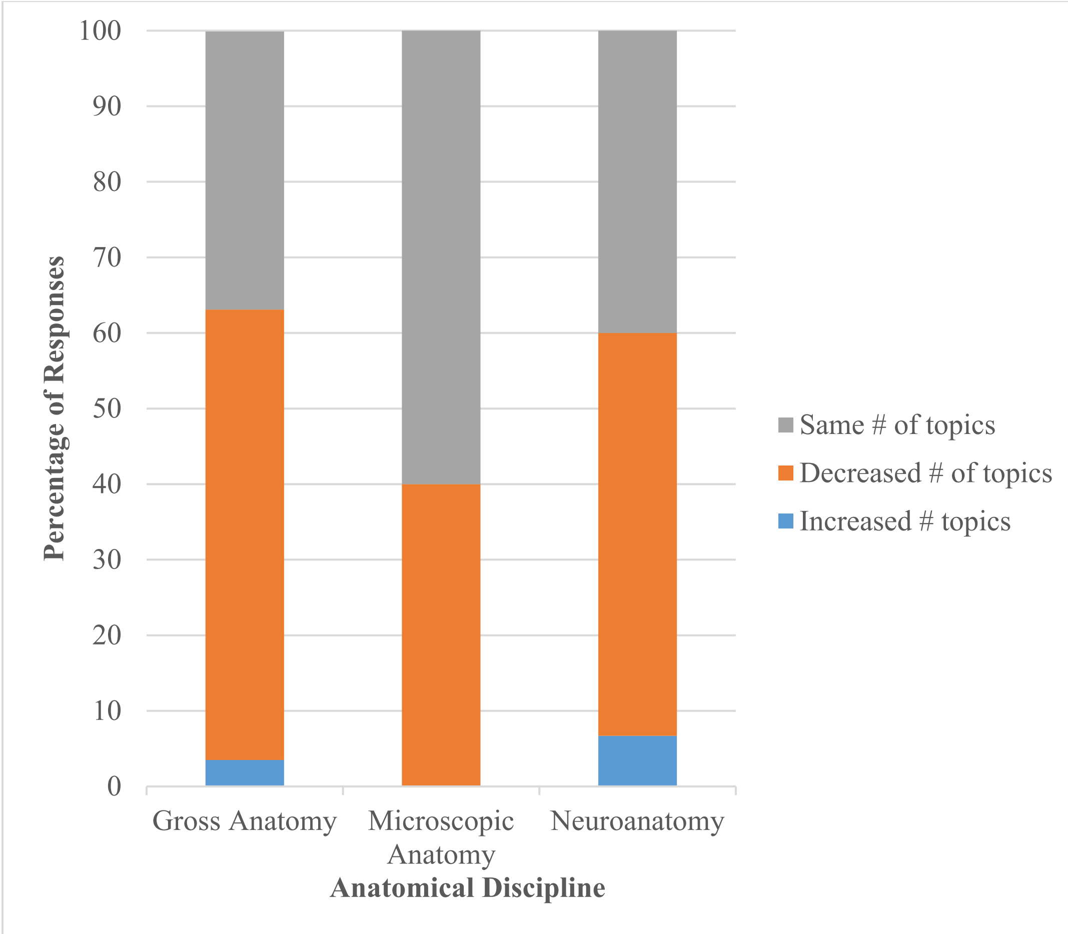
n = 57 for gross anatomy, 11 microscopic anatomy, and 16 neuroanatomy

Most anatomical science faculty stated that the amount of time of instruction decreased as a result of the curricular reform at their institution. Gross anatomy and microscopic anatomy were more likely to say this statement, though almost 40% of neuroanatomy faculty stated the amount of time dedicated to teaching that subject remained the same after curricular reform.

For the change in number of topics (seen in Figure 5.15) taught in gross anatomy after the curricular reform, 34 of 57 (59.6%), faculty stated there was a decrease in number of topics, 21 (36.8%) stated the number of topics stayed the same, and 2 of 57 (3.5%) faculty stated that the number of topics in gross anatomy increased after curricular reform. For microscopic anatomy, 4 of 10 faculty (40%) stated the number of topics decreased after curricular reform, while 6 of 10 (60%) stated there was no change in the number of topics taught after the curricular reform. For neuroanatomy, 8 of 15 (53.3%) faculty stated there was a decrease in the number of topics after their medical school underwent curricular reform, while 6 of 15 (40%) stated there was no change in the number of topics taught. One (1; 6.7%) respondent stated that the number of topics increased after their school had undergone curricular reform.

While most faculty stated the time dedicated to teaching the anatomical science courses decreased within their medical curriculum, fewer faculty stated that there was a decrease in the number of topics taught in the anatomical science courses. The data show that many of the medical schools were teaching about the same amount of material in the anatomical science course, but within a compressed amount of time. This compressed timeframe, in which there are fewer number of hours to teach approximately the same amount of material, can lead to decreased positive perceptions of the curriculum, which is discussed in the next section of this chapter.

Figure 5.15: Change of Number of Topics in Anatomical Disciplines due to Curricular Reform



n = 57 for gross anatomy, 10 microscopy anatomy, and 15 neuroanatomy

Between 50 and 60% of faculty in gross and neuroanatomy stated that there was a decrease in the number of topics taught within the recently revised medical curriculum. Only 40% of faculty who teach microscopic anatomy stated there was a decrease in number of topics in their recently revised medical curriculum. These numbers contrast with the responses about change in amount of time after curriculum reform, showing that in many medical curricula, the same topics are taught, but they are taught within a shortened amount of time.

Data from the survey showed how the anatomical science courses are no longer as often taught as stand-alone courses. For the majority of medical schools that have undergone curricular reform, gross anatomy, microscopic anatomy, and neuroanatomy are now taught in systems-based courses. Additionally, the anatomical science disciplines incorporate various types of active learning pedagogy. While lectures are still the most prominent means to deliver information in the anatomical science courses, many medical schools are now using strategies such as flipped classrooms and team-based learning. Utilization of these different pedagogical methods in the classroom are one way to combat the decreased hours in most of the anatomical courses. Some didactic lectures may be supplemented or even replaced by other methods in order to deliver and reinforce medical knowledge in courses with reduced hours, especially since medical students are often required to learn the same amount of material, but now in a shortened amount of time.

Faculty Perceptions about Curriculum

The final part of the survey asked faculty members about their perceptions of the curriculum at their medical institution. Any respondent who answered the survey, including those who marked "no" to the question "Has your medical school undergone any major curricular reform in the last 10 years?" were able to respond to this question. The quantitative part of this survey consisted of two parts: One part included five Likert items that asked faculty about their perceptions of their medical school's curriculum, and the second part asked the faculty member to rank, on a scale of 1-10, overall how pleased they were with the curriculum at their medical school.

The five Likert statements are as follows:

- I am enjoying teaching within our school's curriculum.
- I feel my students are getting adequate knowledge of Gross Anatomy in our school's curriculum.
- I feel my students are getting adequate knowledge of Microscopic Anatomy in our school's curriculum.
- I feel my students are getting adequate knowledge of Neuroanatomy in our school's curriculum.
- I feel like this medical program is producing adequately-trained medical doctors.

For each of these five statements, the respondent had the option of choosing to what degree they agreed with the statement, including strongly disagree, disagree, neutral, agree, and strongly agree.

Descriptive statistics, including means and standard deviations, were run on these data and are presented in Table 5.8. During the analysis of these data, the data were coded on a 1-5 scale, with strongly disagree equating to a 1 and strongly agree equating to a 5. For the statement, "I am enjoying teaching within our school's curriculum," of the 89 faculty who responded to that statement, 29 (32.6%) responded "strongly agree," 46 (51.7%) responded "agree," 7 (7.9%) responded "neutral," 4 (4.5%) responded "disagree," and 3 (3.4%) responded "strongly disagree." The mean and standard deviation for responses to this statement was 4.06 ± 0.95.

Of the 89 faculty who responded to "I feel my students are getting adequate knowledge of Gross Anatomy in our school's curriculum," 35 (39.3%) responded "strongly agree," 29 (32.6%) responded "agree," 6 (6.7%) responded "neutral, " 14 (15.7%) responded "disagree," and 5 (5.6%) responded "strongly disagree." The mean and standard deviation of responses to this statement was 3.84 ± 1.26.

Of the 78 faculty who responded to the statement, "I feel my students are getting adequate knowledge of Microscopic Anatomy in our school's curriculum," 16 (20.5%) responded "strongly agree," 30 (38.5%) responded "agree," 13 (16.7%) responded "neutral," 10 (12.8%) responded "disagree," and 9 (11.5%) responded "strongly disagree." The mean and standard deviation of responses for this statement was 3.44 ± 1.28.

In response to the statement, “I feel my students are getting adequate knowledge of Neuroanatomy in our school’s curriculum,” of the 79 respondents, 30 (38%) each responded, “strongly agree” and “agree,” while 9 (11.4%) responded “neutral,” 6 (7.6%) responded “disagree,” and 4 (5.1%) responded “strongly disagree.” The mean and standard deviation for this statement was 3.96 ± 1.13.

Finally, in response to the statement, “I feel like this medical program is producing adequately-trained medical doctors,” of the 92 responses, 40 (43.5%) responded “strongly agree,” 28 (30.4%) responded “agree,” 15 (16.3%) responded “neutral,” 5 (5.4%) responded “disagree,” and 4 (4.3%) responded “strongly disagree.” The mean and standard deviation for this statement was 4.03 ± 1.10.

Table 5.8: Means and Standard Deviations of Faculty Perceptions of Medical Curriculum

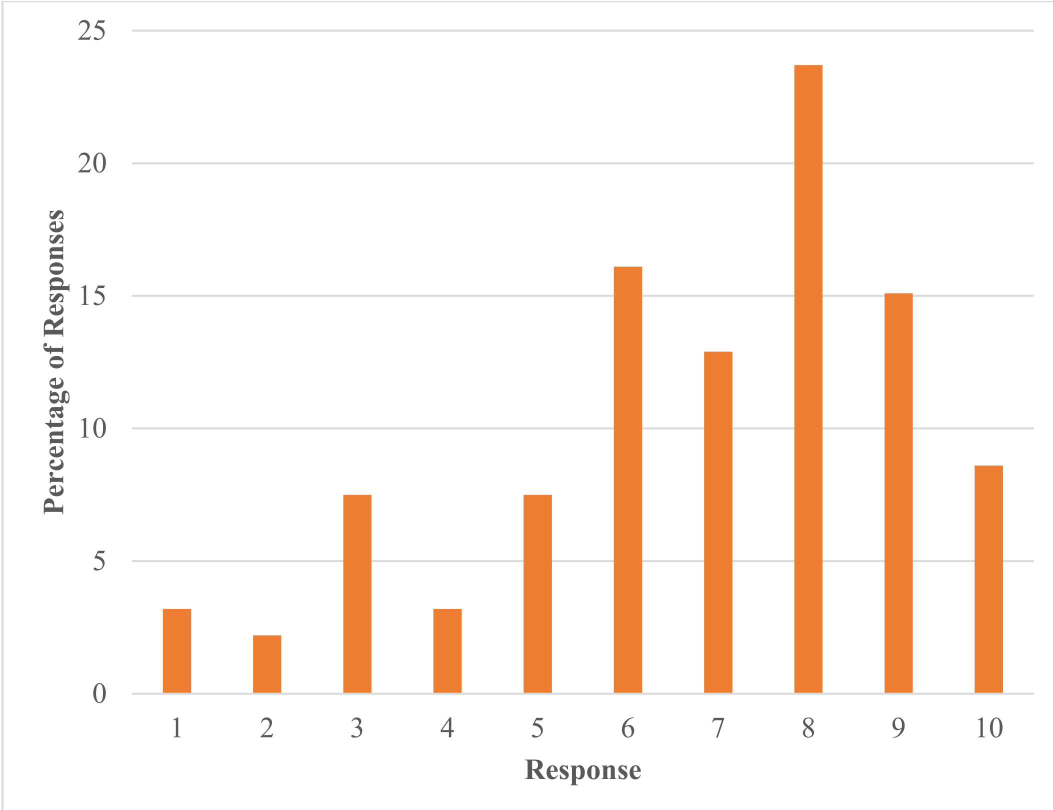
Likert Scale Items about Faculty Perceptions of Medical Curriculum	**Mean ± Standard Deviation**
I am enjoying teaching within our school's curriculum	4.06 ± 0.95
I feel my students are getting adequate knowledge of Gross Anatomy within our school's curriculum	3.84 ± 1.26
I feel my students are getting adequate knowledge of Microscopic Anatomy within our school's curriculum	3.44 ± 1.28
I feel my students are getting adequate knowledge of Neuroanatomy within our school's curriculum	3.96 ± 1.13
I feel like this medical program is producing adequately-trained medical doctors	4.03 ± 1.10

Figure 5.16 displays the spread of responses to the survey question, “Overall how pleased are you with your school’s curriculum?” Faculty had the option to choose from 1-10 on a scale, with 1 being “not at all pleased” and 10 being “extremely pleased.” Similar to the Likert items, any survey respondent had the option to answer this survey question,

whether their medical school's curriculum was revised in the last 10 years or not. Of the 93 people who responded to this question, 3 (3.2%) gave their curriculum an overall rating of 1 out of 10; 2 respondents (2.2%) gave it a 2; 7 (7.5%) gave it a 3; 3 (3.2%) gave it a 4; 7 (7.5%) respondents gave it a 5; 15 (16.1%) gave it a 6 out of 10; 12 (12.9%) gave it a 7; 22 (23.7%) gave it an 8; 14 (15.1%) gave it a 9; and 8 respondents (8.6%) rated their medical school curriculum 10 out of 10. The mean and standard deviation of the responses was 6.78 ± 2.30.

Approximately 76% of faculty answered the question about being pleased overall with their medical school's curriculum with a 6 or higher on the 1-10 scale. However, despite these encouraging remarks, almost 25% of faculty (M=3.84, SD=1.26) stated that they were neutral about, disagreed, or strongly disagreed that their students were getting adequate knowledge of gross anatomy, and 40% of faculty stated that the were neutral, disagreed, or strongly disagreed that their students were getting adequate knowledge of microscopic anatomy. It is interesting to note that most faculty enjoyed teaching in their medical curriculum, even though their reaction to the curriculum was mixed. Further analysis and discussion of possible relationships among the data is forthcoming in this chapter.

Figure 5.16: Percentage of Responses about Overall Perception of Medical School's Curriculum



n = 93
1 = not at all pleased, 10 = extremely pleased

There was a general trend of faculty who stated that they were pleased overall with the curriculum at their medical school. However, almost a quarter of respondents responded with a 5 or below on this survey question, meaning that they had more negative reactions to their medical curriculum. (M = 6.78, SD = 2.30).

Variable Relationships

The next step of the analysis process was to see if any variables had relationships with other variables. Spearman's correlations were conducted with the interval data, which included comparing the overall perceptions of the medical curriculum on a 1-10 scale versus the extent to which the anatomical science courses (lecture and lab, which were asked as separate questions) had changed due to curricular reform (1-5 scale). The following descriptors were used for the 1-5 scale:

- 1 = Changed not at all
- 2 = Changed to a minimal extent
- 3 = Changed to some extent
- 4 = Changed to a moderate extent
- 5 = Changed to a large extent

Additionally, the overall perceptions of the curriculum by the faculty respondents on a 1-10 scale were compared with the extent of involvement of faculty and the administration in the design of the curricular reform on a 1-5 scale. The following descriptors were used for the 1-5 scale:

- 1 = Entirely administration driven
- 2 = Somewhat administration driven
- 3 = Equally driven by administration and faculty
- 4 = Somewhat faculty driven
- 5 = Entirely faculty driven

As a reminder, Bonferroni corrections were calculated to mitigate against Type I (false positive) errors. As there were seven (7) statistical tests run with the overall perceptions of the data using Spearman's correlations, the significance value was reduced from $p<0.050$ to $p<0.007$.

There were no statistically significant findings between overall perceptions of the curriculum and extent to which the anatomical science lab or lecture changed at the 0.007 significance level. However, as seen in Table 5.9, there was a statistically significant but weak positive correlation between the extent of faculty involvement in the development of the curriculum and their perceptions of the curriculum ($r_s = 0.318$, $p = 0.007$), meaning that the more involvement faculty had in the development of the curriculum, as opposed to the development being entirely led by the administration, the greater perceptions were of the curriculum. The data show that allowing faculty to have say in how a curriculum is created and run is correlated with higher/more favorable perceptions of the curriculum, rather than the administration having complete control of the curriculum.

Table 5.9: Spearman's Correlation Comparing Faculty Perceptions and Extent of Involvement in Curriculum

Correlations

		Extent Curricular Reform Admin vs Faculty driven	Overall Perceptions of Curriculum
Extent Curricular Reform Admin vs Faculty Driven	Correlation Coefficient	1	**.318****
	Sig. (2-tailed)		.007
	N	76	71
Overall Perceptions of Curriculum	Correlation Coefficient	**.318****	1
	Sig. (2-tailed)	.007	
	N	71	93

**. Correlation is significant at the 0.007 level (2-tailed).

In order to discover relationships among categorical and ordinal variables, a Chi-square test of independence (also referred to as Pearson's chi square test) was completed. This type of test was used to find relationships between Likert scale variables (ordinal) and many of the categorical variables in the faculty survey, as opposed to Spearman's correlations which looked for relationships among interval data. Additionally, Cramer's *V* for effect size was used to identify the strength of the association between the measured variables which were found to be significant. The following statements served as the Likert scale perception variables in this survey. These statements were coded on a 1-5 scale from strongly disagree to strongly agree.

- I am enjoying teaching within our school's curriculum.
- I feel my students are getting adequate knowledge of Gross Anatomy in our school's curriculum.
- I feel my students are getting adequate knowledge of Microscopic Anatomy in our school's curriculum.

- I feel my students are getting adequate knowledge of Neuroanatomy in our school's curriculum.
- I feel like this medical program is producing adequately-trained medical doctors.

The following survey variables were compared with the Likert scale perception variables in the Chi square analysis:

- Answering yes vs no on "Has your medical school undergone curricular reform in the last 10 years?"
- Amount of time since curricular reform was implemented (less than one year, 1-5 years, 6-10 years)
- Answering yes vs no on "Did you actively participate in the initial development process of the curricular reform?"
- How the anatomies are taught (stand-alone, combined with another discipline, part of a systems-based curriculum, other)
- How the amount of time in the anatomies changed (increased, decreased, stayed the same)
- How the number of topics in the anatomies changed (increased, decreased, stayed the same)

It should be noted that due to the sample size being low (< 5 responses) for some variables (for instance, the number of faculty who answered both "no" to the question "Has your medical school undergone major curricular reform in the last 10 years," and "Strongly disagree" to the statement "I am enjoying teaching within my medical school's curriculum,") the assumptions necessary for using the Chi-square were violated. The Likelihood Ratio was used instead to determine the significance of the relationship. The Likelihood Ratio test expresses how many times more likely the data are under one model (null hypothesis model) than the other (alternative hypothesis model). The null hypothesis is that there is no significant difference between specified populations, while the alternative hypothesis is that there is a statistically significant difference between specified populations in one's data (Field, 2013). For the sake of simplicity, only Likelihood Ratios are reported for all relationships in the textual descriptions of this data analysis. Due to the large amounts of data that were analyzed, only those variables relationships that were found to be statistically significant ($p < 0.004$, after conducting the Bonferroni correction for the twelve statistical tests run on the data) or approaching significance will be reported. The tables of all the results are available upon request.

After running the Chi square test of independence (and viewing the Likelihood Ratios) on the variables discussed above, and after calculating the Bonferroni correction on the *p* value, it was found that no variables showed any statistically significant associations at the 0.004 significance level. However, there was a variable that was approaching statistical significance. With the question "Has your medical school undergone any major curricular reform in the last 10 years?" and the perceptions about students receiving adequate gross anatomy knowledge in the curriculum at the 0.004 significance level, $\chi^2(4, n = 89) = 12.995$, $p = 0.011$. The effect size for this finding (Cramer's *V*) was medium at 0.33 (please see Table 5.2 for an explanation of these effect sizes). The data show that those faculty who answered "no" about their medical school undergoing curricular reform in the last 10 years were more likely to answer "strongly agree" or "agree" about their students receiving adequate gross anatomy knowledge in their medical curriculum. The data show that curricular reform may be a cause of grievances from faculty about how much knowledge their students are receiving, especially in medical programs where there has been a drastic reduction in course time.

Interestingly, there were no statistically significant differences found in faculty perceptions of the medical curriculum and length of time since the curricular reform. One hypothesis for this research study was that the longer the time since the curricular reform had been implemented, the more positive the perceptions would be about the curriculum.

The reasoning for this hypothesis was that the faculty would have become more used to the new structure of the curriculum, and various aspects of the medical curriculum may have been worked out the more time that has passed. However, the data presented here do not support this hypothesis. Similarly, there were no strong associations among faculty who participated in the development of the curricular reform and their perceptions of the curriculum. The last data table showed how there was a statistically significant association between extent of faculty involvement in the curricular reform and overall perceptions of the curriculum, but whether the faculty member participated in the development of the curricular reform was not found to have significant relationships among any of the perception data.

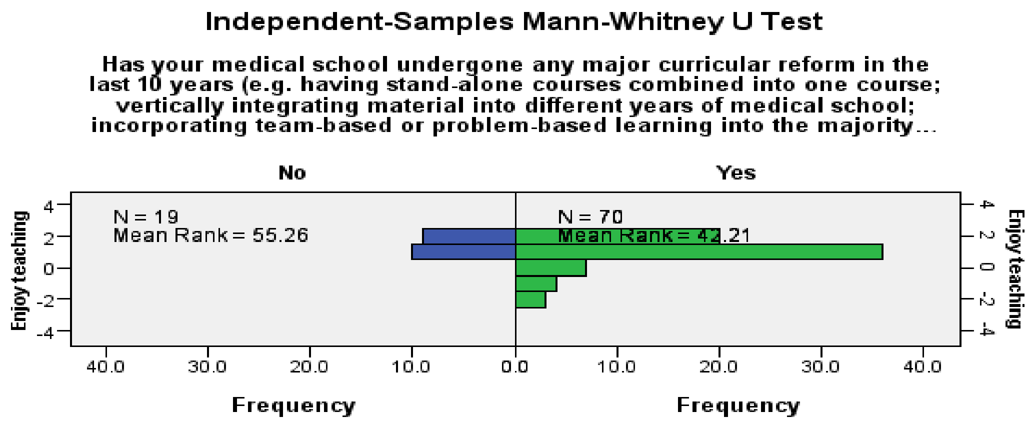
The next statistical test that was performed on the data was the Mann-Whitney U test. This test was run to discover differences in the faculty perceptions of the medical curriculum (the Likert scale perception variables from above) in those faculty whose medical school had undergone curricular reform versus those whose medical school had not undergone curricular reform. This non-parametric statistical test measured the mean ranks of one independent (yes vs no about curricular reform, with yes being coded as “1” and no as “0”) and one dependent group (faculty perceptions on 1-5 scale). While a Chi square test of independence was run on the data to see if there were any statistical significant relationships among the data, a Mann-Whitney U test looked to see if one group (for instance, those whose medical school had undergone curricular reform in last 10 years) had more positive perceptions than another group (those whose medical school had not undergone curricular reform in the last 10 years).

The Mann-Whitney U test also was run on the faculty perceptions from the Likert variables with faculty answering “yes” or “no” about participating in the initial development process of the curricular reform. To discover the strength of the relationship between the variables above (if they showed significant relationships), effect sizes were found. For the Mann-Whitney U test, the common measure of effect size is r (Field, 2013). The absolute value of r, or $|r|$, is presented. The Mann-Whitney U tests that were performed with each Likert Perception variable will be presented in Figures 5.17 to 5.21. As a reminder, the Likert data on the 1-5 scale were recoded to -2 to +2.

For the Mann-Whitney U data, since there were two measures run with it (comparing whether the medical school underwent curricular reform and comparing whether the faculty member was involved in the curricular design), the Bonferroni correction lowered the significance value to $p<0.03$.

For the data comparing faculty perceptions of the curriculum on the 1-5 scale and whether the faculty member’s medical school had undergone recent curricular reform, there were significant differences between those who answered “yes” and “no” when comparing all the Likert variables. The Mann-Whitney U test indicated that the perceptions about enjoyment of teaching in the medical was significantly greater in those faculty whose medical schools had not undergone recent curricular reform (mean rank = 55.26) than those whose medical school had undergone curricular reform (mean rank = 42.21), U = 470.0, $z = -2.147$, $p = 0.032$. The effect size for this measure was 0.23, which accounted for a small effect, according to Table 5.3 from above. A graphic representation of the data may be seen in Figure 5.17.

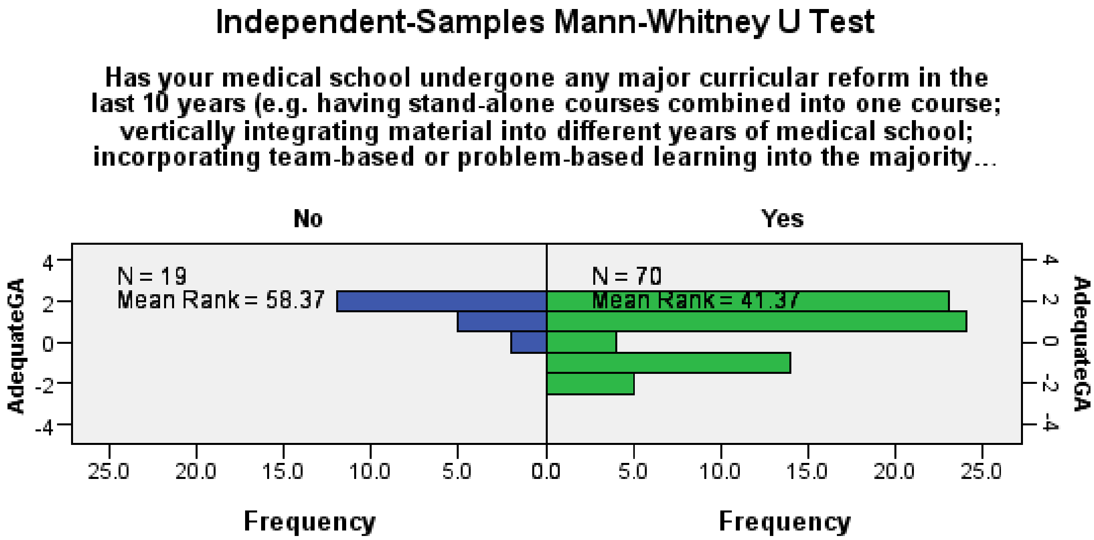
Figure 5.17: Responses about Medical School Undergone Curricular Reform in Last 10 Years Compared to Perceptions about Enjoying Teaching in Curriculum



Faculty who answered "no" about their medical school undergoing curricular reform in last 10 years were more likely to have positive perceptions about enjoying teaching in their school's curriculum. Strongly disagree = -2; Disagree = -1; Neutral = 0; Agree = 1; Stronlgy agree = 2

The Mann-Whitney U test indicated that the perceptions about students receiving adequate gross anatomy knowledge in the medical curriculum were significantly greater in faculty whose medical schools had not undergone recent curriculum reform (mean rank = 58.37) compared to those whose medical school had undergone curricular reform (41.37), U = 411.0, $z = -2.680$, $p = 0.007$. The effect size for these variables was 0.28, which was a small effect. The data may be seen in Figure 5.18.

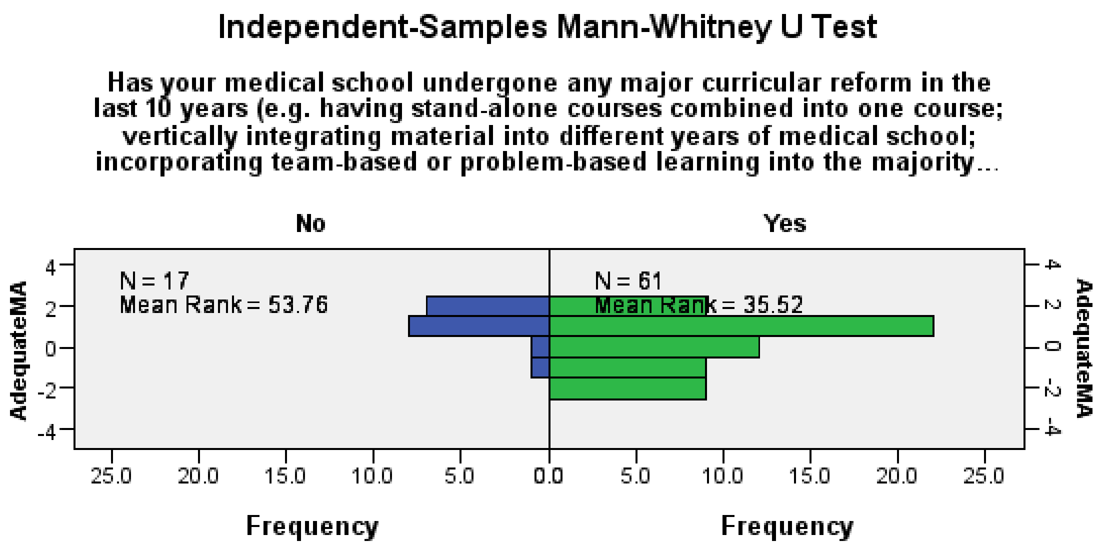
Figure 5.18: Responses about Medical School Undergone Curricular Reform in Last 10 Years Compared to Perceptions about Student Receiving Adequate Gross Anatomy Information in Curriculum



Faculty who answered "no" about their medical school undergoing curricular reform in last 10 years were more likely to have positive perceptions about their students receiving adequate gross anatomy knowledge in the curriculum. AdequateGA = adequate knowldege of gross anatomy; Strongly disagree = -2; Disagree = -1; Neutral = 0; Agree = 1; Stronlgy agree = 2

The results from this statistical measure were also similar for perceptions about students receiving adequate microscopic anatomy knowledge being greater in those whose curriculum had not undergone curricular reform (mean rank = 53.76) compared to those whose medical school had undergone curricular reform (mean rank = 35.52), U = 276.0, z = -3.049, p = 0.002. The effect size was 0.35, which accounted for a medium-sized effect. The data may be seen in Figure 5.19.

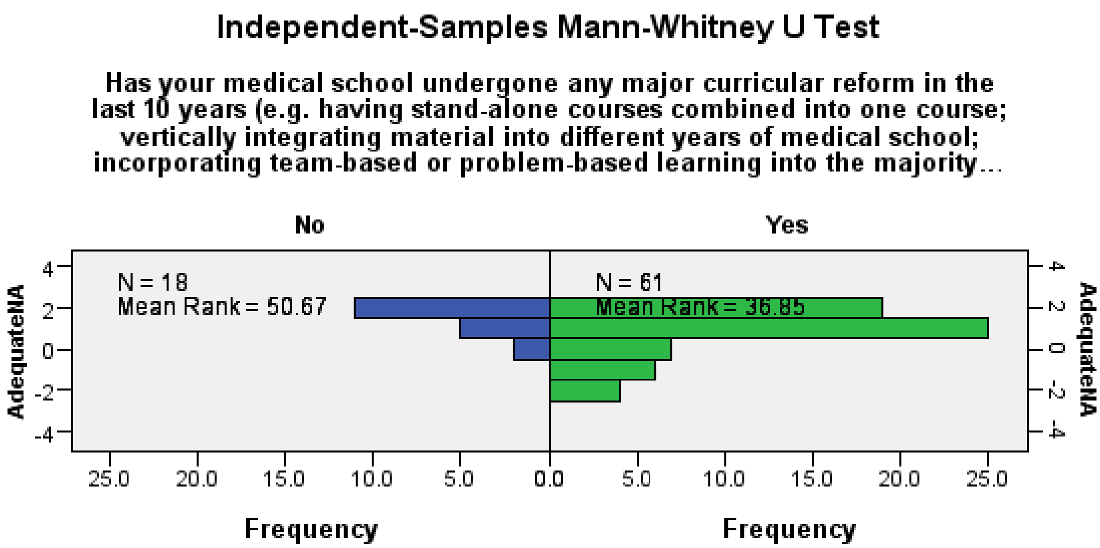
Figure 5.19: Responses about Medical School Undergone Curricular Reform in Last 10 Years Compared to Perceptions about Student Receiving Adequate Microscopic Anatomy Information in Curriculum



Faculty who answered “no” about their medical school undergoing curricular reform in last 10 years were more likely to have positive perceptions about their students receiving adequate microscopic anatomy knowledge in the curriculum. AdequateMA = adequate knowldege of microscopic anatomy; Strongly disagree = -2; Disagree = -1; Neutral = 0; Agree = 1; Stronlgy agree = 2

Additionally, perceptions about students receiving adequate neuroanatomy knowledge were greater in faculty whose medical school had not undergone curricular reform (mean rank = 50.67) compared to those whose medical school had undergone curricular reform (mean rank = 36.85), U = 357.0, $z = -2.381$, $p = 0.017$. The effect size was 0.27, which accounted for a small effect. The data may be seen in Figure 5.20.

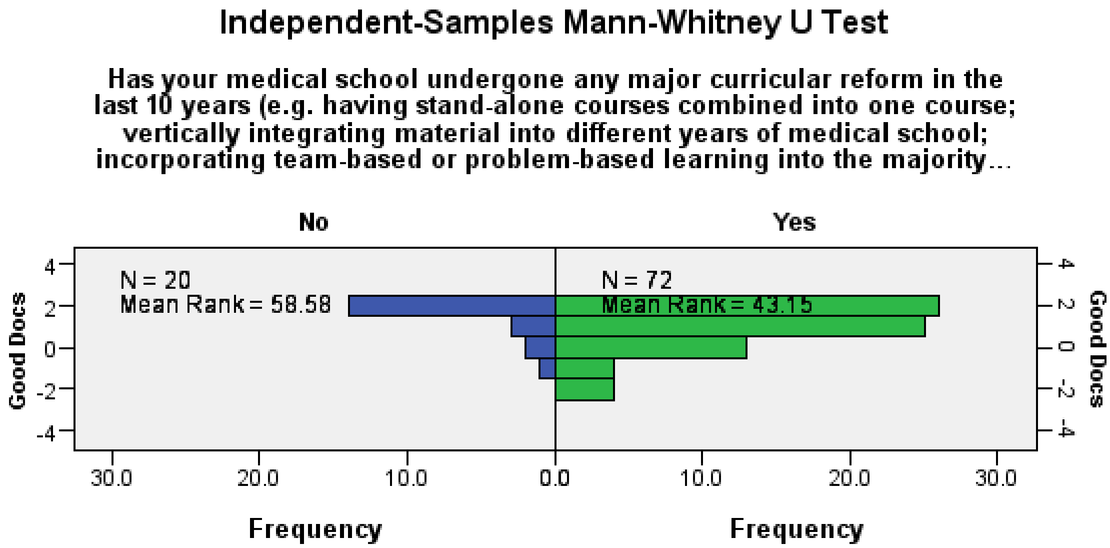
Figure 5.20: Responses about Medical School Undergone Curricular Reform in Last 10 Years Compared to Perceptions about Student Receiving Adequate Neuroanatomy Information in Curriculum



Faculty who answered "no" about their medical school undergoing curricular reform in last 10 years were more likely to have positive perceptions about their students receiving adequate neuroanatomy knowledge in the curriculum. AdequateNA = adequate knowldege of neuroanatomy; Strongly disagree = -2; Disagree = -1; Neutral = 0; Agree = 1; Stronlgy agree = 2

Finally, aligning with the rest of the data, perceptions about the medical curriculum producing adequately-trained doctors was greater in the faculty whose medical schools had not undergone curricular reform (mean rank = 58.58) compared to those whose medical schools had undergone curricular reform (mean rank = 43.15), U = 478.5, z = -2.430, p = 0.015. The effect size was 0.25, accounting for a small effect. The data may be seen in Figure 5.21.

Figure 5.21: Responses about Medical School Undergone Curricular Reform in Last 10 Years Compared to Perceptions about the Medical Curriculum Producing Adequately-trained Doctors



Faculty who answered "no" about their medical school undergoing curricular reform in last 10 years were more likely to have positive perceptions about their medical curriculum producing adequately-trained doctors. Good Docs = agree with medical curriculum producing adequately trained doctors; Strongly disagree = -2; Disagree = -1; Neutral = 0; Agree = 1; Stronlgy agree = 2

These results from the Mann-Whitney U analysis indicate that individuals teaching at medical schools where the curriculum was recently revised are not as enthusiastic about teaching compared to their counterparts who are teaching at schools where the medical curriculum has NOT undergone major curricular reform. These data also show a relationship between medical schools that have undergone curricular reform and the belief by their faculty that students are not receiving adequate basic anatomical science knowledge.

As was mentioned many times in this research, there has been a clear lack of data about faculty perceptions of curricular reform. Even the sparse previous research in this area is more than ten years old. One study from 2003 explained how basic science faculty believed their students were not receiving adequate basic science knowledge in a problem-based learning curriculum (Musal et al., 2003). With this absence of recently published data about faculty reactions to curricular reform at the medical level, the research from this dissertation is vitally important. The qualitative interview data (discussed later in this chapter) will help inform the quantitative findings and provide a greater understanding as to why some faculty have these perceptions about their medical curriculum.

Of note, there were no significant differences in any of the Likert perception variables and whether the faculty member was involved in the initial development process of the curricular reform. Another hypothesis from this research was that faculty who were involved in the designing of the curricular reform would report more positive perceptions about the curriculum. However, the data did not support this hypothesis.

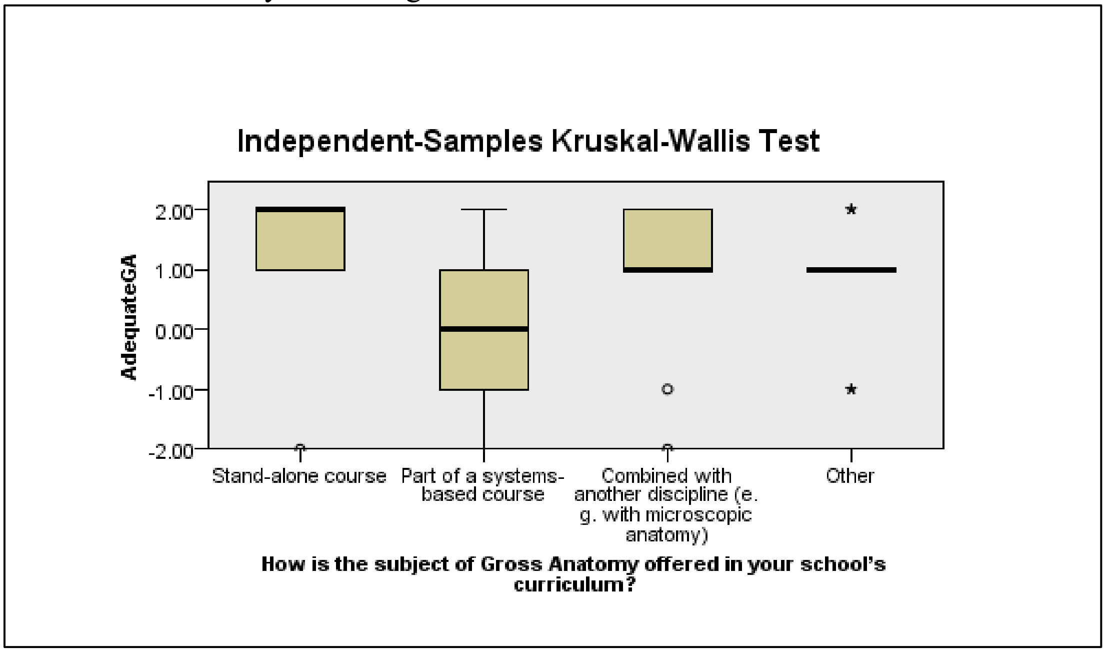
The final statistical test run to discover relationships among the data was a Kruskal-Wallis test. This test measures the medians of more than two groups, and, like the Mann-Whitney test, it is a non-parametric test. For this survey data, the Kruskal-Wallis test compared how the anatomical sciences were taught. Anatomy disciplines taught as stand-alone courses were coded as “1,” disciplines as part of systems-based courses were coded as “2,” disciplines combined with another discipline were coded as “3,” and any of the “other” survey responses were coded as “4.” These variables were then compared with Likert scale faculty perceptions data (on a 1-5 scale, converted to the -2 to +2 scale discussed above). Like the Mann-Whitney U non-parametric measure, means are not calculated. For the Kruskal-Wallis test, medians instead will be presented with the data. Additionally, similar to the Mann-Whitney U test, effect sizes were also found and reported as the absolute value or *r,* or $|r|$.

Since there were three statistical tests run with the data (one for each anatomical science discipline), the significance value was lowered from $p<0.050$ to $p<0.017$.

The only variables that showed statistical differences were the way in which gross anatomy was taught and perceptions about students receiving adequate gross anatomy knowledge in the curriculum. Specifically, perceptions about students receiving adequate gross anatomy knowledge in the curriculum were significantly higher in those faculty whose medical school's taught gross anatomy as a stand-alone course (median = 2) compared to when it was taught as part of a systems-based course (median = 0), $H(3) = 10.2$, $p = 0.017$. The effect size for this relationship was $r = .400$, accounting for a medium-sized effect.

Figure 5.22 is a box plot from the data which displays the different ways in which gross anatomy was taught in the medical curriculum and the perceptions about students receiving adequate gross anatomy knowledge in the curriculum, on a -2 to +2 scale. Note how the medians from both "stand-alone" and "combined with another disciplines" are greater than that of "part of a systems-based course," once again confirming what was shown previously about how faculty have more negative feelings about their students acquiring adequate knowledge in a revised medical curriculum taught by organ systems-based units, where there may be drastically reduced course hours and not enough time for the students to learn what they need to know.

Figure 5.22: Responses about How Gross Anatomy Courses Organized in Medical Curriculum and Perceptions about Students Receiving Adequate Gross Anatomy Knowledge in Medical Curriculum



n = 58

When gross anatomy was taught as a stand-alone course, faculty perceptions about their students receiving adequate gross anatomy knowledge increased, especially when compared with gross anatomy as part of a systems-based course. Adequate GA = students receiving adequate gross anatomy; Strongly disagree = -2; Disagree = -1; Neutral = 0; Agree = 1; Strongly agree = 2

These data are very interesting because faculty stated that, in medical programs that had recently undergone curricular reform, gross anatomy was most often organized into organ systems-based courses. It could be that faculty prefer gross anatomy taught separately because, oftentimes, it cannot easily be grouped into organ systems-based units, as gross anatomy is often taught regionally (McBride and Drake, 2018).

In fact, in a study conducted by McKeown et al. (2003), medical students whose anatomy course was integrated into organ systems units performed worse on an examination of surface anatomy. This transition to integrating the anatomical sciences into systems courses may not only have effects on faculty attitudes toward the medical curriculum, but also on student performance related to the anatomical sciences. In another report about integration of material into systems-based formatting, Van der Veken et al. (2009) found that there was a steeper learning curve for students in an integrated curriculum compared to students in a traditional, discipline-based curriculum. Students are not used to this way of thinking, and so there needs to be thought that has gone into integrating material deliberately into the medical curriculum.

It should be noted again that faculty respondents to the survey only had the option of choosing one way in which their anatomical science discipline is taught. However, a few faculty respondents stated their course was both integrated with other foundational courses early in the curriculum and then brought back in organ systems courses. Not having the ability to choose multiple options on the survey question may have impacted the results, and this is discussed as a limitation in Chapter 7.

Data from this quantitative analysis of the faculty survey responses has shown that most medical schools have undergone some sort of curricular reform in the past ten years. This is a trend that will continue into the near future as well. However, with this curricular reform comes many drastic changes, such as organizing the anatomical science courses differently, reducing the amount of time dedicated to teaching the anatomical subjects, and the utilization of many different active learning strategies. While some of these changes may be beneficial to student learning, such as incorporating team-based and problem-based learning in the classroom, other aspects of curricular reform may come with consequences. Many faculty stated, especially for gross anatomy when incorporated into systems-based units, that their students were not receiving adequate knowledge in the subject. One outcome of gross anatomy, or any anatomy discipline taught within systems-based units, could be that there is more focus on the pathology of the system, rather than the foundational sciences. This foundational information is imperative for the students to learn prior to transitioning into pathology and pathophysiology of the body. And, many times, these sciences, especially gross anatomy, are difficult to incorporate into systems units because gross anatomy is more often taught regionally. Additionally, many medical programs, when undergoing curricular reform, may cut foundation science hours drastically. This reduction may cause both faculty and students to become frustrated with the curriculum one year, and from that feedback, the curriculum may change slightly, such as scaling back on the numbers of active learning strategies used in the classroom.

While this quantitative analysis has shown many important trends and relationships among the data, it is also crucial to understand what is happening with the curricular reform, why is it happening, and what are the effects of the reform. Quantitative data can only show so much, and that's why, in mixed methods analysis, qualitative data analysis is also vital to understand the big picture of the data. This next section delves deeper into faculty responses to the open-ended questions on the survey.

Qualitative Data Analysis of Faculty Survey

The open-ended portion of the faculty surveys consisted of ten (10) questions which served to further explain the answers to the quantitative questions. Eight (8) of the ten questions are represented in this chapter. The author decided not to include the data from the other two (2) questions because, after reading through the open-ended responses, it was determined that there was nothing more added to the data than what was already found from the data of the quantitative questions. These two questions that were not included in this analysis were “If you answered yes (to the question ‘after the implementation of the major curricular reform, have there been any additional substantial revisions?’) please briefly explain what the substantial revisions were,” and “Please explain any of your answer choices (to the Likert questions).” The eight questions that were included in this analysis were divided into three categories: (1) questions specific to the overview of the curricular reform, (2) questions specific to the anatomical disciplines, and (3) questions specific to faculty perceptions of the curriculum.

Responses to the open-ended questions may be placed into more than one code. Often, faculty gave a multi-sentence response to the question. For example, in describing how curricular reform has changed the medical curriculum, there may be many features of that response that could be coded in many different areas. The author presents the number of total responses to each question, but the frequencies of the codes and sub codes will not equate to the total faculty who responded due to these multi-coded responses. The codebook for the data is found in Appendix G.

General Overview of Curricular Reform

There were two (2) open-ended survey questions which related to the general overview of the curriculum. One question asked, “If you answered yes (to your medical school having undergone a major curricular reform in the last 10 years), please describe what the major curricular reform entailed.” The data for this question is seen in Table 5.10. Another question was “Please give an example of 1-2 classes that have changed due to curricular reform and how they have changed compared to the previous curriculum.” The data set is seen in Table 5.11.

While both of these questions are very similar, it was the goal of the first question (major curricular reform) to understand what, in general, changed due to the curricular reform. The faculty could read this as how the entire curriculum (all four years of the curriculum) changed due to curricular reform. Or they could read it as how the pre-clerkship years changed due to curricular reform. The goal of the second question (example of 1-2 classes) was to gather information on how specifically a course changed due to the curricular reform. Since many of the faculty who responded to the survey taught in the anatomical sciences, they talked about how those courses specifically changed.

Some faculty responded to the first question in a fairly succinct manner, while others wrote a lengthy paragraph to describe their curricular reform. Since this question was very broad, it seemed logical that some faculty might elaborate on the curricular reform at their institution.

For the results displayed in Table 5.10, the author assigned four (4) main codes: *Integration*, *Reduction in Time, Active Learning,* and *New Medical School*. There were eighty-nine (89) responses to this open-ended question. The *Integration* code was the most common at a frequency of 70. This code was for answers that spoke about combining certain things in the curriculum, including the sub codes of *Organ Systems* (34), *Courses* (20), *Clinical* (9), *Vertical* (4), *Horizontal* (2), and *Spiral* (1).

The following is an exemplar quote about the integration of courses: “Discipline specific courses (e.g., anatomy, physiology, etc.) were replaced with ‘integrated’ courses in which similar material was combined into new combinations of topics (e.g., gross anatomy, histology, and embryology combined into one course).” Another faculty respondent described how most of the curriculum "moved from disciplined based to systems based, but gross anatomy/embryology (previously a 14-week course) was kept as a block at the beginning, reduced to 7.5 weeks." Previous research has also shown this integration of disciplines to be a common trend of medical curricula (Brooks et al., 2015; Klement et al., 2017). The author proposed this type of content organization (foundational courses first followed by organ systems-based blocks) as an ideal component of a medical curriculum in Chapter 4.

The second most common code was *Reduction in time* (36), and it was for answers related to a decrease in parts of the curriculum, including a *Shortened pre-clerkship curriculum* (18) and *Contact hours* (18). Some medical faculty stated their pre-clerkship curriculum was reduced to "1.5 years…and 2.5 clinical." Vanderbilt University School of Medicine also reduced their pre-clerkship curriculum to 1.5 years by moving a required research experience to the post-clerkship phase and altering the students' break schedules (Yengo-Kahn et al., 2017). Other faculty stated their curriculum had reduced hours dedicated to the teaching of the anatomical sciences, including "lectures are now 25 minutes." This reduction of contact hours for the anatomical disciplines has been discussed previously by Drake and his colleagues through surveys sent out to medical course directors (Drake et al., 2002, 2009, 2014; McBride and Drake, 2018).

Another code was *Active Learning* (frequency of 30), including the sub codes which were examples of active learning utilized in the curriculum: *TBL* (11), *PBL* (9), *Case-based* (5), *Flipped classes* (2), and *Alone* (3). The *Alone* sub code was for responses that just stated, "active learning." Some medical schools incorporated multiple modalities of active learning, "team-based, problem-based, case-based, self-directed learning," as was also seen from the quantitative data. Ransom et al. (2017) described the introduction of PBL modules into a gross anatomy course at Tulane University School of Medicine.

The final code was *New Medical School* (frequency of 7). There were no sub codes generated for this code. This code included medical schools that had been created in the last ten years, so there was no previous curriculum.

Table 5.10: Codes and sub codes for open-ended survey response: Example of major curricular reform

Codes	Sub codes	Frequency	Select text examples
Integration		70	See below
	Organ Systems	34	Stand-alone discipline courses were replaced with systems-based, integrated coursework in the preclinical years
	Courses	20	Discipline based courses retained in year 1 but more added and some other combined into an interdisciplinary molecules to cells course.
	Clinical	9	Integration of the basic sciences with clinical correlations… Combining the M1 (normal) content and M2 (clinical) content…
	Vertical	4	From a standard, course-block based curriculum in 2013 we changed to a vertically integrated curriculum…
	Horizontal	2	Horizontal integration of basic sciences in first-year curriculum…
	Spiral	1	integration of anatomy into several of the blocks both horizontally and vertically
Reduction in time		36	See below
	Shortened pre-clerkship curriculum	18	Transition to 18-month systems-based curriculum Restructuring to 1.5 years preclerkship and 2.5 clinical

	Contact hours	18	No lectures; all material is online. Gross anatomy lab reduced to about 77 hours, with only half of each group in lab at any time All didactic teaching has been reduced by half, i.e., lectures are now 25 min. Gross anatomy per se has been eliminated.
Active Learning		30	See below
	Team-based learning (TBL)	11	Introduction of team-based learning into our patient centered learning integrated curriculum.
	Problem-based learning (PBL)	9	we went from a traditional lecture based program to PBL
	Case-based	5	We do case-based learning in small groups change to more case based, small group
	Flipped classes	2	combining courses, emphasizing flipped classrooms
	Alone (no other description)	3	Transformed to an active learning, integrated curriculum
New Medical School		7	We are a new medical school based on a system-based curriculum with PBL. Anatomy is integrated into each system block. Currently undergoing curricular change

There were no responses from the faculty that seemed surprising to the author, as she had experience with colleagues at other medical institutions that had very similar sentiments about medical curricula. It should also be noted that it was helpful that a few faculty mentioned how their medical school was completely new, as opposed to just having a new curriculum at an older institution. This was a valuable distinction when looking at the overall data in an attempt to discover nuances in faculty responses. These medical schools that were new may have *begun* with the “trendy” curricular aspects, such as inclusion of integration and active learning, rather than revising their curricula like the older medical schools have done.

Table 5.11 displays the results to the question, “Please give an example of 1-2 classes that have changed due to curricular reform and how they have changed compared to the previous curriculum.” The author discovered four (4) main codes from the data: *Reduction in time, Dispersal of Content, Integration, and Non-didactic Learning.* There were sixty-six (66) responses to this open-ended question. The *Reduction in time* code was the most common with a frequency of 44. This code contained two (2) sub codes: *Content* (34) and *Compression of Courses* (10). The reduction of *content* sub code included anything that was reduced in the courses taught within the curriculum, such as the number of dissections that students complete: “Decreased contact hours in Gross Anatomy have forced us to use prosections for some of the more time-consuming dissections (superior orbit; facial nerve; ischioanal canal; spinal cord; perineum).” The *compression of courses* was in reference to the courses themselves having reduced hours, such as “neuroscience was compacted from a 4-month course to a 6 week block.”

Dispersal of content (frequency of 16), was its own code and contained no sub codes. This code was seen to be the opposite of *compression of courses* – instead of courses being reduced from, say eight weeks to six weeks, the course content in this code may be spread out across an entire year, such as in organ systems courses, as in “Anatomy and embryology content, previously a 9-week emersion course, is now taught throughout the 18 month basic science phase.”

Another code from the data was *Integration* (frequency of 27) with sub codes of *Disciplines* (18) and *Organ systems* (9). There were not as many *Integration* sub codes found as the last prompt.

Non-didactic Learning (frequency of 25) included the sub codes of *Active Learning* (13) and *Lab* (12). There were not enough distinct forms of active learning mentioned as in the last question, so *active learning* was considered its own sub code. *Lab* was considered a form of non-didactic learning because it is not entirely lecture-focused and contained enough responses to warrant its own sub code. One faculty stated how histology labs were eliminated due to curricular reform "and replaced by tutorial sessions or self-study quizzes both using electronic slides." As of the writing of this dissertation, there have been no published reports about medical schools eliminating their microscopic anatomy labs (or moving them to be completed on students' own time). However, some research has demonstrated how students have more self-directed learning time for learning microscopic anatomy lab material than they did in a previous curriculum (Khalil et al., 2013).

Not all lab changes were found to be negative and due to reduced hours in the curriculum. One faculty member stated, that in their gross anatomy labs they use "high definition video cameras and large screen monitors so that we can zoom in and out to see all relevant structures."

It is important to note that a faculty member may have responded to this prompt describing a course as having reduced number of hours dedicated to teaching the content, but that the content may also be spread across different aspects of the curriculum – for example, within organ systems-based units. In this regard, the faculty responses would be coded into many different areas – organ system, reduction of content, and also dispersal of content. This coding of responses into multiple areas held true for many of the faculty responses.

Table 5.11: Codes and sub codes for open-ended survey response: Example of classes that changed due to curricular reform

Codes	Sub codes	Frequency	Select text examples
Reduction in time		44	
	Content	34	Other than Anatomy, all of the basic science courses were eliminated and the basic science content was distributed across a series of courses called "Mechanisms of Health and Disease." Each mechanism course focuses on a particular group of mechanisms. The first two are focused on normal health and the second two focus on disease states.
	Compression of Courses	10	neuroscience was compacted from a 4 month course to a 6 week block
Dispersal of Content		16	Anatomy has been spread out over several blocks Gross Anatomy and Neuroanatomy have been broken up from stand-alone classes to components of organ-based blocks. So gross anatomy is offered in the Musculoskeletal/Dermatology Block, Cardio-Pulmonary Block, GI/Renal Block, Bran & Behavior Block, and Endo/Repro Block. Neuroanatomy will be offered in the Brain & Behavior Block.
Integration		27	See below

	Disciplines	18	previously, we had 'medical neuroscience'. This was replaced with a 'neuro-psych block' which included neuroscience with neurology, psychiatry and pharmacology Biochemistry, Cell Biology, Genetics, Pathology, etc. have been integrated into our Mechanisms of Health and Disease.
	Organ Systems	9	Histology course was a stand-alone course with practical labs involving glass slides and microscopes. Currently, it is integrated into system-based integrated curriculum. Physiology, Gross & Microscopic Anatomy and others have been combined based on relevant systems.
Non-didactic Learning		25	See below
	Active Learning	13	… team based activities have been introduced into our second year patient centered learning small group sessions and histology labs use virtual slides exclusively. As an additional note, we moved into a new building two years ago. This building has no lecture theatres. All classrooms are designed to accommodate a multitude of instructional approaches. This is slowly transforming the types of instructional approaches that instructors are utilizing. More active learning, in the form of TBL has been implemented. Some material has been moved from live lectures to online lectures to be more flexible with time.
	Lab	12	Lab component of the musculoskeletal block is now completely taught through pre-dissected cadavers to ensure that we are able to cover all musculoskeletal content in only 6 labs.

Anatomical Disciplines

There were three (3) open-ended survey questions that asked how specifically the lecture and/or lab experience changed in each anatomical discipline due to curricular reform. If the faculty member taught in that anatomical discipline, then he or she had the opportunity to answer this question. There was a quantitative question prior to this open-ended question that asked to what extent the lab and lecture had changed due to curricular reform. This goal of this open-ended question was to explain the faculty answer choices to those previous questions.

Table 5.12 displays the codes and sub codes from the gross anatomy faculty who answered the question. The author discovered four (4) main codes from the data: *Reduction of Content*, *Non-didactic Learning*, *Clinical Integration*, and *Reversal of Curriculum*. There were sixty-two (62) faculty who answered this question. The *Reduction of Content* code was the most common with a frequency of 59. This code contained sub codes of *Didactic Lectures* (31) and *Dissections* (28). One of the more principal aspects of the data was that many medical programs incorporated more cadaver prosections to make up for reduced hours in the lab, which was demonstrated by this response, “Lab time has been reduced and requires a very active prosection and team-driven experience to complete as needed.” Data explained above from the quantitative part of the survey showed that student-led dissections were still the prevalent gross anatomy lab component, but that prosections were also an important part of the lab.

Non-didactic Learning was another code from the responses, with a frequency of 16. Much like the same code from the previous question, this code contained the sub code of *Active Learning* (10). Additionally, the sub code of *Technology* (6) was found. Again, because there were not enough separate active learning modalities mentioned in the responses, the term *active learning* itself was used as a sub code. One faculty stated the how their curriculum "nearly completely abandoned lectures in favor of online narrated PowerPoint presentations supported by a comprehensive anatomy web site."

Instead of utilizing only the term integration, the faculty responses to this prompt were specific in that the gross anatomy lecture and/or lab changed with incorporating more *Clinical Integration* (frequency of 7) in the course, such as "lectures are given as clinically relevant topic-specific lectures by practicing physicians i.e., the chairman of ophthalmology teaches students the eye. Lab is focused on clinically relevant anatomy." This code had no associated sub codes.

The final code was an interesting and unexpected one: *Reversal of curriculum* (frequency of 3). Some faculty responded that their gross anatomy course changed initially, such as by eliminating cadaver dissection, but, for one reason or another, that action was reversed. One example of this was with "the initial curricular reform, anatomy labs were reduced in number and were instructor-led demonstrations. After about 2 years, [we] reverted back to student-led dissections, which are still used now." Klement et al. (2011) stated, after a curricular revision at Morehouse School of Medicine, students' examination scores in the Biochemistry course decreased, possibly due to the compression of the content into a much shorter time span. While that Biochemistry course was not completely reverted to how it was taught in the previous curriculum, faculty offered an in-course enrichment program for students who were not passing that course.

The *reversal of curriculum* code is very important to note because it's showing that the administration reviewed the curriculum to see what was working and allowed the curriculum to be in a state of examination and change if something was not working, rather than just letting things be the same until the next curricular reform. However, faculty and administrators must be careful when considering completely returning to how something was done previously. As one faculty respondent stated, the reversal process may require "a substantial effort both in terms of resources and faculty re-engagement." While this code was not one of the more frequently-stated ones, it is still one to take heed of, as it may have implications with other medical curricula in the future.

Table 5.12: Codes and sub codes for open-ended survey response: How Gross Anatomy lecture/lab has changed

Codes	Sub codes	Frequency	Select text examples
Reduction of Content		59	See below
	Didactic Lectures	31	With fewer hours allotted to lecture, many lectures have been compressed or lightened in content. there are not traditional lectures but briefing sessions containing anatomy and radiology concepts
	Dissections	28	Lab time has been reduced and requires a very active prosection Prosection-based small groups; Student dissection now optional
Non-didactic Learning		16	See below
	Active Learning	10	more team-based and problem-based learning which previously was minimal
	Technology	6	Newer technologies for lecture, addition of new imaging modalities in lab

Clinical Integration		7	Lecture content moved toward more clinical based lectures. Major lectures are taught by clinicians, more clinically oriented.
Reversal of curriculum		3	all gross anatomy lectures and labs were stopped out, but it did not work, and we re-introduced both lectures and full body dissection. this was a very difficult process since re-introduction required a substantial effort both in terms of resources and faculty re-engagement.

Table 5.13 displays the codes and sub codes from the microscopic anatomy faculty who answered the question. The author discovered three codes from the data: *Lab*, *Active Learning*, and *Integration*. In contrast to the number of faculty who answered the gross anatomy question, only twelve (12) faculty responded to this question, and that is possibly what led to there being fewer codes and sub codes from the data. The most common code was *Lab* with a frequency of 12. That code contained the sub codes of *Virtual Microscopy* (7) and *Reduction of faculty-guided labs* (4). For microscopic anatomy lecture/lab, there was no general reduction described about the discipline, as was described about the gross anatomy discipline. Rather, microscopic anatomy discussed how specifically the in-person labs utilized virtual microscopy. It was obvious that a switch from optical to virtual microscopy would be part of curricular reform, as many medical schools have eliminated optical microscopy sessions (Wilson et al, 2016). But faculty also stated that the switch from optical to virtual microscopy in the lab lent itself more easily for lab modules to be completed out of the classroom: "The traditional

histology lab with microscopes was eliminated. There are now PowerPoint-based 'labs' that students do on their own or in small study groups."

The final codes applied to the data included *Active Learning* (frequency of 3) and *Integration* (2) and had no additional sub codes. For *active learning*, all of the responses talked about how faculty employed non-didactic principles to teach the microscopic anatomy lab content. The previous paragraph explained how faculty no longer fully guide the students in labs, and now other measures are used to deliver the information, such as "flipped classroom in the lab follows self-study with virtual microscope slides."

The data from the microscopic anatomy faculty is also represented in their answers to the quantitative questions of the survey. From Figure 5.13, approximately 80% of the faculty stated that the microscopic anatomy lab had changed by a moderate or large extent due to curricular reform. The transition of labs from in person to out-of-class activities may help explain those answer choices.

Table 5.13: Codes and sub codes for open-ended survey response: How Microscopic Anatomy lecture/lab has changed

Codes	Sub codes	Frequency	Select text examples
Lab		12	See below
	Virtual Microscopy	7	Change from exclusively microscope based, to a hybrid, to exclusively virtual microscopy
	Reduction of faculty-guided labs	4	Lab has gone from being an in-class session to almost entirely self-directed modules students complete on their own time.
Active Learning		3	Lectures are videotaped so students can watch or re-watch them. Flipped classroom in the lab follows self-study with virtual microscope slides

Integration		2	The major change has been integration of histology lectures with gross anatomy lectures in a new integrated Human Structure course.

Table 5.14 displays the codes and sub codes from the neuroanatomy faculty who answered the question. This question had one more faculty response (13) compared to the 12 from the microscopic anatomy faculty. *Integration* (frequency of 5) and *Active Learning* (2) were also codes from the data. The most frequent code from neuroanatomy faculty was *Reduction* (14) with sub codes of *Didactic Lecture* (7) and *Lab* (7). As opposed to many of the microscopic anatomy labs transitioning to out-of-class labs, many of the neuroanatomy labs were completely eliminated: "A single, voluntary lab is now offered." In a survey of neuroanatomy course directors, the average number of neuroanatomy laboratory hours decreased from 21 in 2014 to 13 in 2018 (Drake et al., 2014; McBride and Drake, 2018).

Table 5.14: Codes and sub codes for open-ended survey response: How Neuroanatomy lecture/lab has changed

Codes	Sub codes	Frequency	Select text examples
Reduction		14	See below
	Didactic Lecture	7	Lectures reduced by 50% minimum
	Lab	7	The traditional neuroanatomy lab was eliminated. A single, voluntary lab is now offered.
Active Learning		5	Moved to more PBL. Used to do clinical cases related to structure and function.
Integration		2	The neuroscience/neuroanatomy curriculum was already integrated with other disciplines

Faculty Perceptions of Curriculum

There were three questions in the category about faculty perceptions of the curriculum. The first question asked, “Please comment on some things that you like about your school’s curriculum.” The second asked, “Please comment on some things that you do not like about your school’s curriculum.” The third question asked, “Do you have any constructive suggestions on how to improve you school’s curriculum?” Any faculty member, whether their medical school had recently undergone curricular reform or not, had the opportunity to answer these questions. It was the goal of these questions to ascertain the overall feelings of the faculty about the curriculum in which they teach. For the question about giving suggestions on how to improve the curriculum, thirty-six (36) faculty who answered the other two questions did not answer this question. This lack of response may be from a myriad of reasons: it was near the end of the survey, so the faculty could have survey fatigue; they may not have had any suggestions on how to improve it; or, they might have thought, even if they did have suggestions, that those suggestions are moot because no one would listen to them.

Table 5.15 displays the results to the question about what the faculty like about the curriculum. The author discovered three (3) main codes from the data: *Organization*, *Student-Centered,* and *Support*. There were eighty-two (82) responses to this open-ended question. The *Organization* code was the most common with a frequency of 82. The sub codes within this code included *Integration* (34), *Clinical Exposure* (23), *Content* (12), and *Systems* (9). One faculty member stated how they liked that gross anatomy was the only course taught at one time “so students are focusing on anatomy.” Another comment stated how the faculty member liked that students would be able to see information more than once in the curriculum, “I am glad we stuck with a two pass curriculum giving students a grounding in basic science and applications in normal before moving onto pathophysiology/pathology etc..” Additionally, faculty liked that their students had exposure to clinical material and experiences early on in their academic career.

Another code for the data was *Student-Centered,* with a frequency of 31. The sub codes here were *Outcomes* (17) and *Active Learning* (14). For the *outcomes* sub code, faculty liked how well their students were doing in the curriculum, such as on their USMLE Step examinations. The following passage is from a faculty member demonstrating how they enjoyed various integrative and student-centered aspects of their medical curriculum:

> “Good ongoing curriculum assessment and improvement process that fosters vertical and horizontal integration. Excellent clinical skills training across all 4-years (100% pass rate on Step 2-CS). The small, student-centered culture at the medical school is a rewarding environment for educators and students. Not just a hospital with a med school attached.”

The final code for the data was *Support* with a frequency of 25, and it included the sub codes of *Interdisciplinary* (9), *Dedicated Faculty* (8), and *Receptive Administration* (5). For the sub codes of *interdisciplinary*, many of the faculty liked that they were able to work with others from different disciplines, including clinical instructors. Faculty also liked that there are other *dedicated faculty* who work at the medical school – that when the faculty are dedicated to their craft, the students show their appreciation for that: “This makes a big difference for students, for the integrity and smooth running of a course, and allows us to provide a superior student experience in their first year.” In interviews of faculty at the University of California-San Francisco

School of Medicine, Muller et al. (2008) found very similar themes with the faculty there, about how they enjoyed the collaborative atmosphere of a new medical curriculum.

Finally, the faculty stated that they liked that there was *receptive administration* within their medical school: "strong centralized support from the college (staff, resources, etc.)." This may align with the sub code of *reversal of curriculum* – that when something was not going very well in the curriculum, the administration was willing to look at it and possibly change the curriculum back to what it was before. However, despite these encouraging remarks, only 5 faculty of 82 who responded to this question talked about the administration. The next section shows many more faculty who were discouraged by not having a major role with the curriculum at their institution.

Table 5.15: Codes and sub codes for open-ended survey response: What faculty like about school's curriculum

Codes	Sub codes	Frequency	Select text examples
Organization		82	See below
	Integration	34	The integration of anatomy with physiology and other disciplines within organ system courses is effective. The integration of ultrasound into anatomy is good. An integrated, organ system approach is a better way to teach medical students than traditional discipline-based courses as it is more aligned with how they will use the information in their clinical careers.
	Clinical Exposure	23	Students seem to be happy with the early exposure to clinical experiences Most of the curriculum is clinically-relevant…the curriculum includes early clinical exposure, opportunities to apply knowledge…

	Content	12	I am glad we stuck with a two pass curriculum giving students a grounding in basic science and applications in normal before moving onto pathophysiology/pathology etc.. Organized, learning objective driven, active learning incorporated to a reasonable extent, multiple modalities of content delivery
	Systems	9	Anatomy, histology, and embryology are taught during a first semester anatomy course. Later in the systems-based courses, these disciplines are revisited Organ system approach with integration across multiple basic science disciplines. Anatomy, which is regionally taught in 5 body regions, integrates with 4 organ systems: MSK, GI/Liver, Neuroscience and Reproduction.
Student-centered		31	See below
	Outcomes	17	…and our medical students score well on the neuroanatomy and anatomy USMLE shelf exams and Step 1 in the anatomical sciences. (100% pass rate on Step 2-CS). The small, student-centered culture at the medical school is a rewarding environment for educators and students. Not just a hospital with a med school attached.
	Active Learning	14	PBL, TBL and peer-instruction are better than traditional lectures, if done well. The move away from lecture-based gross anatomy is really good and does not emphasize the rote memorization that has dogged this topic.

Support		25	See below
	Interdisciplinary	9	In the process of designing this curriculum, faculty from all campuses have been communicating much more. I actually feel like I've got a broader support system within the institution. All faculty seem open and willing to help any student Excellent camaraderie and friendly working relationship among all faculty
	Dedicated Faculty	8	We have many dedicated instructional faculty. This makes a big difference for students, for the integrity and smooth running of a course, and allows us to provide a superior student experience in their first year.
	Receptive Administration	5	There is strong centralized support from the college (staff, resources, etc.).

Table 5.16 displays the results to the question about what the faculty do not like about the curriculum. The author discovered two (2) main codes: *Education Format* and *Issues with Faculty Involvement.* There were seventy-nine (79) faculty responses to this question. *Education Format* was the most frequent code (83) and included the sub codes of *Content Concerns* (45), *Decreased Time* (18), *Worrisome Outcomes* (15), and *More Resources* (5).

Content Concerns included such components as concern with eliminating a free-standing course, such as embryology and cell biology, leading to decreased emphasis on those subjects. Previous research has found that course hours dedicated to embryology content have decreased in recent years (McBride and Drake, 2018) and there has been a debate about what specifically related to embryology should be taught to the medical students (Cassidy, 2015). Additional content concerns included integration not being done correctly – that while faculty applauded the use of integration in the curriculum, it needed to be done in a manner that was not overwhelming for students. There was a concern that the students would not be able to “link ideas and fact” when the content was reduced.

The *decreased time* sub code was mentioned many times already, and it was seen to be a major concern in curricular reform, with faculty feeling like they were “rushed” with teaching the material and the students learning the material. The *worrisome outcomes* sub code was in opposition to what some faculty stated for the last question – in that some faculty were concerned that students were not receiving either enough training or adequate training to become competent medical doctors. One faculty member stated how their pass/fail grading system “coupled with the very low passing standard has greatly undermined the students' incentive to study.” This sub code aligns with some of the results from the previous section – that faculty whose medical school has undergone curricular reform are concerned their students are not receiving adequate knowledge of the anatomical disciplines. Spring et al. (2011) conducted a systematic search on relevant literature looking at pass/fail curricula and students’ wellbeing and academic outcomes. Their results showed that a pass/fail curriculum does not harm students academically overall, and it helps improve their overall mental health. However, the faculty concerns from these data about a medical school’s grading system should not be overlooked. More research needs to occur in this area to see if students are acquiring the amount of knowledge they need for their future careers as physicians. The implementation and preliminary effects of a pass/fail grading system will be discussed in the next chapter about a case study completed at IUSM-B.

For the *more resources* sub code, some faculty stated that there were not enough resources in the curriculum for students to utilize in their education. They called for more infrastructure to support the various types of active learning used in the medical curriculum. One faculty member's concerns for many of the above codes are illuminated from this passage:

> "Limited infrastructure to support TBL, small groups or flipped classroom formats that encourage active, cooperative learning and problem-solving. Clinical faculty are not given enough protected time for medical education. Video recording of all lectures - and limited mandatory attendance - has reduced in-class attendance for lectures and large group conferences. Grading by z-scores can be problematic when all students are attaining satisfactory performance."

The *Issues with Faculty Involvement* code (frequency of 24) contained the sub codes of *Contribution* (16) and *Administrative Reach* (8). *Contribution* had two types of responses: some faculty stated that they were not as involved in the curriculum as they had hoped. Other faculty were involved in the curricular reform, but they had little time and energy for other things, such as teaching in their classes. The curricular reform had no good balance in administration and faculty involvement.

Some faculty stated in the last question (about what they liked about their medical curriculum) that they were happy about how receptive the administration was to issues that came up during the curricular reform process. However, in this question about what faculty do not like about the curriculum, many stated that their administration was overstepping or putting too much pressure on the faculty (a*dministrative reach*), leading to these negative feelings. Some faculty went so far as to call the curriculum administration "zealots" and "autocratic."

Table 5.16: Codes and sub codes for open-ended survey response: What faculty dislike about school's curriculum

Codes	Sub codes	Frequency	Select text examples
Education Format		83	See below
	Content Concerns	45	elimination of free-standing embryology and cell and tissue biology course have reduced emphasis on these topics.
	Decreased Time	18	We started with a 2-year preclinical curriculum but have ended up with much less time. I wish we had designed an 18-month preclinical curriculum from the very beginning.
	Worrisome Outcomes	15	The pass-fail grading coupled with the very low passing standard has greatly undermined the students' incentive to study.
	More Resources	5	we need a more stream-lined dissector that is easier for students, more prosections, more faculty development of clinical faculty on the basic science connections
Issues with Faculty Involvement		24	See below
	Contribution	16	It's very taxing on the anatomy teaching faculty, who carried most of the load of curricular reform, and most of the load of the M1/M2 curriculum.
	Administrative Reach	8	Lack of communication about impending changes from the administration; Extremely slow response from administration on faculty support or requests for additional faculty

Some faculty stated they were involved in their curricular reform, though they bore too much of the responsibilities of the curriculum. Others stated their curriculum was driven by the administration with minimal to no faculty input. Both of these scenarios are cause for concern. The next section will discuss ways in which faculty believe their curriculum can overcome some of these issues and create a more cohesive medical curriculum for all involved.

Table 5.17 displays the results to the question asking the faculty if they had any constructive suggestions on how to improve their school's curriculum. The author discovered three (3) main codes from the data: *Education, Faculty,* and *Evaluation*. There were forty-one (41) responses to this question. The *Education* code was the most frequent (25) and included the sub codes of *Add Content* (12), *Delivery* (8), and *Innovation* (5).

For the *add content* sub code, some faculty stated that they wanted to increase contact hours, such as in the gross anatomy lab and have a focus on dissection over prosection and newer technology. One faculty member stated that it's important to keep up with new technology for information delivery, but that cadaver dissection "should remain an important component of the educational experience." They go on to state "we have quite literally hundreds of medical and allied medical professional post graduates who attend our CME programs that utilize cadavers. Although they enjoy seeing our virtual reality facilities, they quickly lose interest and want to work on cadavers." Wilson et al. (2018) conducted a meta-analysis on anatomy lab pedagogy and found that students performed just the same whether they used cadaver dissection or some other pedagogical method. However, cadaver dissection can also teach some skills that other laboratory pedagogy may not, including team work, communication, and how to cope with death/dying (Flack and Nicholson, 2017).

For the *delivery* sub code, some faculty stated that they wanted to see even more active learning sessions in the curriculum. Others stated that they wanted to discover the best ways to "optimize self-directed learning segments" in the classroom. For the *innovation* sub code, faculty stated how they should be encouraged to be innovative in their classroom and "improve their own courses." The following quotation is one that demonstrated the various aspects of the *Education* code for constructive suggestions, calling for the anatomical sciences to be introduced in a fundamental course, and then re-introduced in systems-based courses and in electives.

> "I believe that gross anatomy can ideally be placed into the new curriculum by including it with the 'Fundamentals' block of instruction. That is, it should arguably be placed in its entirety as a dissection-based unit early in the curriculum - even before the systems-based modules begin, and then supplemented by brief reviews as the students begin the different systems-based modules in their preclinical year-and-a-half. It should also then be supplemented as elective options during the last semester of the med student's senior year. This permits the medical students expanded opportunities to take advantage of many valuable options to learn anatomy."

For the *Faculty* code, with a frequency of 10, there were sub codes of *Encourage Involvement* (8) and *Increase Communication* (2). These two sub codes are fairly self-explanatory in that the faculty wanted to be more involved in designing the curriculum as well as have better communication between faculty members and the administration.

Finally, for the *Evaluation* code, with a frequency of 9, there were two sub codes: *Focused Outcomes* (7) and *Feedback* (2). Very similar to the negative perceptions about the curriculum in regard to student outcomes, some faculty wanted the standard of passing to be increased, or they wanted class attendance to be mandatory, all which would hopefully lead to improved outcomes on board exams and in the clinical years. Additionally, the faculty wanted the administration to listen to their students and take their feedback on the curriculum seriously.

Table 5.17: Codes and sub codes for open-ended survey response: Suggestions for improving curriculum

Codes	Sub codes	Frequency	Select text examples
Education		25	See below
	Add Content	12	I would increase the overall length of the anatomy course. Alternatively, I would add in refresher courses (maybe of focused topics within anatomy) later in the curriculum. More hours in gross lab would always be nice. Maybe increase the number and variety of upper-level anatomy dissection electives
	Delivery	8	Add more active-learning sessions. . .we received by students and quantum knowledge gain! shorten preclinical training to 1.5 years to STEP 1, so required clinical rotations could be lengthened and add more integrated review of basic science in clinical training.
	Innovation	5	Encourage more innovation on a course-by-course basis. The college seems most interested in sweeping, curriculum-wide initiatives. Innovative faculty who improve their own courses are less visible and their ideas don't get shared very easily.
Faculty		10	See below
	Encourage Involvement	8	For it to be successful, the impetus for reform will need to come from the teaching faculty, and not from administrators playing the "LCME card". It would be great if our medical faculty could get more release time to contribute to our curriculum.
	Increase Communication	2	communication between administrative issues on curriculum reform and changes in the calendar needs improvement

Evaluation		9	See below
	Focused Outcomes	7	Increase the standard for passing In the future, I think the focus on the medical school curricula will be to prepare students to do well on the Board Exams…
	Student Feedback	2	At this point, we just need to really look at what our students are learning and take their feedback seriously. We need to be willing to make some changes after this first rollout year.

From these responses by faculty to the open-ended questions on the survey, it was found that the most common ways in which the medical curriculum changed for the pre-clerkship years was reduced course hours, more integration of clinical content, and more incorporation of active-learning methods in the classroom. For the anatomical sciences specifically, the reduction of hours and content was a common trend, especially the reduction of didactic lectures. Some items that faculty liked about their curriculum included the organization of courses, promotion of more integration of material, and clinical exposure. However, some things that were concerning for the faculty was lack of faculty involvement in the curricular decisions. Faculty would like to see increased communication with administrators on the best ways to organize a medical curriculum. The next section discusses results found from the qualitative analysis of faculty interviews. It is the hope that through this analysis, quantitative and qualitative data from faculty surveys will be confirmed. Additionally, it is the hope that through the thematic analysis of the data, further insights on faculty perceptions of their medical curricula will be found.

Qualitative Data Analysis of Faculty Interviews

Seventeen (17) faculty interview participants consented to this part of the research by answering “yes” to the question, “Would you be willing to participate in a brief phone interview to expand upon your perceptions of curricular reform at your school?” After checking “yes,” the faculty wrote in their name, phone number, and email address. These interviews served as a chance for faculty to expand upon their answers to the survey questions. Many of the same questions asked as quantitative questions in the survey were asked in the interview (see Appendix C for a list of the interview questions). The specific methods used to conduct this part of the research are located in both Chapter 4 and in the beginning of this chapter. The codebook for the data may be found in Appendix H.

All four of the geographic regions of the United States from the AAMC (Association of American Medical Colleges, 2018) were represented from the faculty participants, with the majority (9; 52.9%) coming from the Central region, four (4; 23.5%) from the Southern region, and two (2; 11.8%) from both the Northeast and Western regions. Most the faculty participants (11; 64.7%) taught in a large-sized medical school (see Table 4.1). Five (5; 29.4%) taught in a medium-sized medical school, and only one (1; 5.9%) taught in a small-sized medical school.

For the anatomical subjects taught by these faculty participants, the overwhelming majority of the faculty (13; 76.5%) taught gross anatomy. Six (6; 35.3%) faculty participants taught microscopic anatomy, and six (6; 35.6%) taught neuroanatomy. Three individuals (3; 17.6%) taught all three of those anatomical subjects, two (2; 11.8%) taught gross anatomy and microscopic anatomy, and one (1; 5.9%) taught microscopic anatomy and neuroanatomy.

The remainder of Chapter 5 details the thematic analysis of the seventeen (17) faculty interviews.

The codes, categories, and themes discovered from the thematic analysis of the faculty interviews are described below. There are three tables (Tables 5.18, 5.19, 5.20) which present one particular theme found from the data, and all its corresponding categories and codes, along with exemplar quotations from the participants, credited via numerical identifiers in parentheses at the end of the quotation. Included with each of the tables, the author discusses in further detail the meaning behind each code and how those codes formed both the categories and the overall themes.

Theme 1: There exists an overall administrative control of the medical curriculum

Table 5.18 displays the codes and categories that formed the theme "There exists an overall administrative control of the medical curriculum." One of the research questions for this project asked, "What were the medical schools' stated reasons for curricular reform at their institutions?" During the analysis of the data to answer this question, the author found that the data supported the fact that the medical curriculum was primarily driven by the administration. Faculty may have had some input into the curriculum, and this was evident in some of the interview responses, but, overall, the administration was the primary controller of the curriculum. One faculty member noted "every curricular reform came from top-down, came from the dean of curriculum we were just given the guidelines." One of the jobs of deans and other high-ranking administrators in medical schools is to oversee the medical curriculum, but some faculty saw designing a new medical curriculum as a reason to justify administrative jobs and "move to the next level" of the administrative hierarchy.

Additionally, reasons that the administration decided to have their medical school undergo curricular reform included meeting LCME standards and being competitive with other medical schools that were also changing their curriculum, evidenced from the following statement: "Leadership saw that we were falling behind the national trend of switching to a systems-based program and they thought it would help the students be more successful on the national boards." This statement also reinforces data from previous research on the reasons behind undergoing curricular reform (Brooks et al., 2015; Klement et al., 2017; Mejicano et al., 2018).

Many of the faculty who had been at their institution for decades stated that the current curricular reform at the institution was not the first one to occur, that it's "been one curricular reform after another." Not only was there constant change with the medical curriculum, but some faculty stated that their medical school had reverted to a curricular type that existed in previous iterations of the curriculum – with the medical curriculum acting as a "pendulum," going from one iteration to another. One faculty member talked specifically about the organ systems-based aspect of the medical curriculum:

> "We have gone through three different curricular reforms, and they have gone basically through one mode of teaching to another and then back. We were an organ-based systems about 25 years ago, and everybody threw that out. Then back to regional and blocks, and now we are throwing that out and going backing to organ based."

This "pendulum" was an interesting finding. Previous research on the subject of medical curricular reform reverting to a previous iteration has not been published, though this was a fairly common finding in the author's research. It is not known why research on this topic has not been published.

The overall feelings from the faculty were indifference, in that they believed, since the administration ran most parts of the curriculum, that they could not do much to change that. As one faculty respondent described, “we have to do it this way. My philosophy with all this is that I agree with it or not, it’s you know, certain aspects of it are beyond my control.” This sentiment was very striking, with faculty who enjoy teaching medical students feeling like they don’t have control over how they are allowed to teach those students. Furthermore, faculty had feelings of uncertainty in some of the responses, very similar to the indifference, in that faculty knew that they could not change the curriculum, but, also, that they were unsure if their curriculum was actually beneficial for the students, in terms of how students perform on their USMLE Step examinations: “I feel bad that the students aren’t getting that they might expect when they come into medical school. And I wish the assessment format was slightly different.”

Table 5.18: Theme 1: There exists an overall administrative control of the medical curriculum

Categories	**Codes**	**Select Text**
Reasons for Curricular Reform	Administration-driven	every curricular reform came from top-down, came from the dean of curriculum we were just given the guidelines. (02)
	Competition with other medical schools	Leadership saw that we were falling behind the national trend of switching to a systems-based program and they though it would help the students be more successful on the national boards. (17)
	LCME	an upcoming LCME accreditation this year triggered much of the changes (04)
Need for Change	Constant Change	it's been one curricular reform after another. And they only run about every 10 years. People feel the need to change. (05)
	Reversal	We have gone through three different curricular reforms, and they have gone basically through one mode of teaching to another and then back. We were an organ-based systems about 25 years ago, and everybody threw that out. Then back to regional and blocks, and now we are throwing that out and going backing to organ based. (15)
Reactions from Faculty	Indifference	So I don't really like the curriculum we have here but I'm not willing to devote the time and energy to switch it. (01)
	Uncertainty	So that's the one thing that worries me and something that's probably not unique to XXX is sometimes the faculty don't really get to voice their opinions on what they think should be changed or reassessed or improved upon. I don't know how you can change that unless you give them a position of authority. (10)

Theme 2: The goal of the medical curriculum is to streamline the teaching and learning of the basic science information

Table 5.19 displays the codes and categories which compose the theme of "The goal of the medical curriculum is to streamline the teaching and learning of the basic science information." Another research question from this project was "How are anatomical science classes organized within medical school curricula that have been recently revised?" Through the analysis of the data, it was found that the overall pre-clerkship curriculum, including the anatomical sciences, were organized in a manner allowing for the efficient teaching of medical information. The primary reason to have the teaching of the material become more streamlined in the revised medical curriculum was due to the reduction in overall course hours in the curriculum. Some medical programs had their entire pre-clerkship curriculum reduced from 2 years to 1.5 years, while others just had course hours reduced. This reduction was especially evident with the anatomical science courses, where one gross anatomy faculty respondent stated that there was a loss of "close to 40% of course time… in order to cover gross anatomy while still doing dissection and covering, really, I call them 'anatomy's greatest hits' because we don't really go into much detail."

Much of this loss in course hours was to align with LCME Standards for reaccreditation.

> "The school says that the LCME accreditation listed a number of changes that they needed to make in order to be in compliance with accreditation, and one of those was a reduction in the amount of lecture hours. Actually a total reduction in the amount of time the students are spending in the classroom."

The LCME does not state exactly how many didactic and non-didactic hours there should be in a medical curriculum. However, some LCME standards state that a medical school should have "required clinical experiences" (Standard 6.2), "self-directed learning and lifelong learning" (Standard 6.3), and "content of sufficient breadth and depth to prepare medical students for entry into any residency program and for the subsequent contemporary practice of medicine" (Standard 7). Oftentimes, in order to align with these standards, medical schools will reduce their lecture hours to allow more time for non-didactic learning and independent student learning.

More non-didactic, active learning techniques were utilized in the classroom after curricular reform, rather than straight didactic lectures. These different active learning techniques included, "increasing the number of small group activities…team-based learning, that we called case-based collaborative learning." Additionally a faculty responses further explained that these active learning strategies are now part of the contemporary medical curriculum: "…student independent learning, clinical correlations, all these sort of commonly seen goals of modern curricula, in terms of active student-centered learning."

However, for the most part, no broad topics in the anatomical sciences were completely eliminated; rather, anatomic detail was reduced, such as with gross anatomy lab where they decreased some "dissection sequences and just using prosections. For example so we did the face, they don't dissect all the branches of the facial nerve any more, they just prosect one or two of that." This quote matches data from the faculty surveys, where amount of time was reduced in the basic sciences, but the number of topics was not changed as much.

In terms of more exposure to the clinical aspects of medicine, faculty were seeing positive student reactions. One faculty respondent stated,

> "Certainly the attitude is better. They like to learn the pathology immediately after all the basic science component. One of the complaints we have always had, the students would say, why are we learning this? So by pairing that, one day they learn the anatomy and histology and then a day or two later about the pathology, that makes it more relevant to them. They know; they see it. They get the payoff pretty immediately."

This is a very positive finding because in the report from Cooke et al. (2010) there was an urge for medical educators to provide early clinical immersion for medical students, so that they do not have to wait until their clerkship years to be exposed to clinical material.

Interdisciplinary collaborations were a very common occurrence in revised courses and also helped to streamline the medical curriculum. In many revised curricula, faculty worked with other faculty from different disciplines or with clinician educators who "bring their own clinical relevance." Many faculty stated that this interdisciplinary collaboration had both advantages and disadvantages – with the primary disadvantage of "their time is valuable and it's difficult for them to be fully engaged in the course." The same sentiments about interdisciplinary collaboration was found by interviews of faculty conducted by Muller et al. (2008).

Table 5.19: Theme 2: The goal of the medical curriculum is to streamline the teaching and learning of the basic science information

Categories	Codes	Select Text
Reduction of Time	Shortened Pre-Clerkship Curriculum	So it used to be 2 years of pre- clerkship and then the Step 1 exam. And then it changed to 18 months pre-clerkship. (04)
	Reduced Contact hours	Well first of all, we lost close to 40% of our course time. It went from 157 hours down to 96. We lost a lot of course time so in order to cover gross anatomy while still doing dissection and covering, really, I call them 'anatomy's greatest hits' because we don't really go into much detail. (15)
	Compensation (decreased detail)	So gross anatomy has had to attempt to find ways to cut minimize the contact hours. Most of that was done by taking out some dissection sequences and just using prosections. For example so we did the face, they don't dissect all the branches of the facial nerve any more, they just prosect one or two of that. (09)
Organization	Integration	So now it's integrated with what is called Human Structure. Basically, the major part is anatomy and then it integrated the basics of radiology and then embryology. (04)
	Non-didactic learning	I think the hallmark of our new curriculum, that we like most, that institutions are moving to more active learning. This I think it's probably been the most radical change we have…increasing the number of small group activities. We really, as I mentioned, have a lot of new teaching methods we are asking faculty to do. We are doing small group sessions that are team-based learning, that we called case-based collaborative learning. (12)
	Self-regulated learning	The faculty encourage students to look things up and engage in discussion with their colleagues. And students come back and say, well we are paying all this tuition and teaching ourselves. We shouldn't pay any tuition. There was some frustration with the self-regulated push. However, now after having gone through this for almost a year, I think things are back to

		normal. Students are much more comfortable directing their own learning. (11)
	Efficiency	We basically have 12 weeks of instruction but it’s spread out over 17 weeks. It is a course that’s retained. I think much of what was done previously but we’ve actually streamlined and removed content that we feel students don’t need those types of detail in their first pass.(08)
	Interdisciplinary	I work with others. I consider myself the primary instructor. Neuroanatomy is still a pretty large component. During the first weeks of the course, I teach about 90% myself. But when we progress into the other topics, where I don’t have much of the expertise, then we have people from neurology, oncology, pathology who are involved in teaching components of the course. (07)

Theme 3: Regardless of how the medical curriculum is structured, students will do what they need to do in order to succeed.

Table 5.20 displays the codes and categories for the theme of "Regardless of how the medical curriculum is structured, students will do what they need to do in order to succeed." A research question from this project was "What are faculty perceptions of curricular reform at their institution?" Faculty were asked in many different manners in the interview about their perceptions of various aspects of the medical curriculum at their school, including how they believed their students were doing, what are accurate measures of the success of a medical program, and what they believed the point of curricular reform to be.

Most faculty stated that their students' USMLE Step exam scores had not changed in any major way compared to previous years. Some faculty stated that scores "initially dipped, but now they are back up. This year, my students scored as high as they ever have since 2004."

Others stated that scores "initially increased, but then there was a fall back." Those faculty stated, however, that their medical school was able to counsel students who were not doing very well and allowed them to take the Step exam again. Most faculty stated that students are going to do as well as they can on the board exams, irrespective of how they are taught. This finding of lack of an interaction between curricular type of examination scores has been discussed in previous research (Cuddy et al. 2013; Hecker and Violato, 2009).

When pressed about how their students were doing and then asking how the success of a medical students can be accurately measured, many responses from the faculty were of uncertainty. Faculty were not quite sure how to measure the success of a medical program, especially since it's primarily those USMLE Step scores that are reviewed for a medical program and compared to the national average. It's those scores that will also assist the students with their residency placement. But, as one faculty stated, "It certainly is no indication on what kind of physician you will be."

A few faculty expanded on some additional measures of assessment that should be taken in to consideration, such as medical knowledge retention into residency, having critical thinking skills when the students come across a problem that they don't know right away, and having the skills to engage with other health professional workers in a professional environment. However, the faculty also stated that there is not a definable way to measure student success and compare it with other medical schools, at least not as easily as board scores can be compared: "I don't think we are measuring those, at least not well. We say we are a competency-based curriculum, but we don't even use a consistent rubric from one course to the next for each competency. And there too, it becomes a challenge for some of the things that are hard to quantify." This faculty respondent goes on to say that these aspects of medical education are just as important as the Step exam scores, but they don't know how those other aspects can be measured: "We should be asking our administration this question."

This theme was also underlined from the faculty responses to the interview question, "What is the point of curricular reform?" with faculty approaching that question from a three-fold type of view, culminating in an overall realistic viewpoint. First, many faculty stated that the point was to justify the jobs of the administration, which ties in with the first theme found from this analysis. Second, faculty reiterated the point that their students will persevere no matter what type of curriculum is thrown their way – their USMLE Step scores will not drastically change. And third, after acknowledging those first two points, many faculty stated the point of curricular reform was to create an "interesting and stimulating" environment for the students to learn, which includes the integration of the material, the exposure to early clinical experiences, and the active learning strategies employed in the classroom, things that will "stay with them much longer."

Table 5.20: Theme 3: Regardless of how the medical curriculum is structured, students will do what they need to do in order to succeed

Categories	Codes	Select Text
Current Evaluative Measures of Medical Curriculum	Board Scores	I know residency programs use board scores, and they weren’t intended to be used that way. I don’t know if board scores really measure how much students have learned in their first two years. I think there’s a lot of other stuff in there. If you’ve taken a really good board prep course, you are going to do better. If you are just a really smart person, you are going to do better. If you just struggle, you are going to struggle all the way, especially if you have never had a board review course. (05) I think we have a lot of people on pins and needles waiting to see how they will do on Step 1, just curious to see if it changes. My expectation is that it’s not going to be any different than previous years. You know if they have made it to this point already, then typically they are pretty capable of doing well. I think they are going to be ok. I don’t expect any significant changes on Step 1. (07)
	Student Evaluations	I don’t think it should be a surprise because we have spent the last year and a half asking our current second years what they don’t like. ‘What’s wrong?’ ‘What don’t you like about this?’ ‘How could we do better?’ and I think it's got a little too far. It’s one thing to do better and want student feedback. It’s another to basically structure everything we do around feedback. The students are not the experts. (07)
Hopeful Outcomes after going through Medical Program	Knowledge Retention	So our job is to make the curriculum as interesting and stimulating to the students as possible to make them help them learn and retain it well. I do think small group activities, our students have weekly small group sessions with clinical cases, it really, I think will stay with them much longer, doing it that way. (16)

	Critical Thinking Skills	And part of empirical based reasoning maybe has nothing to do with setting a broken bone or doing some sort of diagnostic, but it's medical reasoning. It's looking at facts and accumulating knowledge and synthesizing it to be able to achieve some sort of conclusion from that. We are really very well positioned to start the beginning of that process where people can start to look critical thinking. (15)
	Professionalism	They spent several afternoon a week in the learning communities, working with a physicians, on cases and things where we have clinical skills. They have interprofessional experiences where they work with nurses and physical therapists. We also have something where they go out with a physician and work with them one afternoon a month for the entire first two years. And that allows them to get a first-hand experience taking history and things like that. I think all those things were really good positives of curriculum reform. (09)
Reactions	Realism	So I think there's been some good things about curricular reform. We have gone to a system where the kids see a lot more relevant what they are doing sooner. When they are going through the first two years, they are able to see the why a little bit quicker. Also then, with the curriculum reform, part of that, not only has the basic sciences been remodeled. But we have made room in the afternoon, so they can have earlier clinical experiences. We had some exposure to that in the old curriculum, but now even more so with the new curriculum. … I think all those things were really good positives of curriculum reform. Part of me is a little bit cynical to some degree. I mean, you know, a lot of the changes that we make are forced on use by the LCME in terms of active learning and not lecturing as much. I don't know if there is a ton of evidence for that. I think they want us to change just to change. For the most part, that I mentioned before, have been positives. They are good things. (09)

	Uncertainty	Well a lot I think much of it comes down to personality perseverance of the individual student, and I don't know that we make that much difference in making them good doctors (01)

Final Thoughts Regarding Analysis of Survey and Interview Data from US Allopathic Medical School Faculty

Most of the surveyed faculty who teach in the anatomical sciences at their medical school stated their medical school had undergone major curricular reform in the last ten years. However, the specific curricular reform varied across medical schools. As was previously stated in the Chapter 4 of this research, there is no one way to organize a medical curriculum, and this conclusion was also confirmed in this chapter, where faculty described a wide variety of medical curricula, especially with how the anatomical sciences are organized into the medical curricula – not only with how courses are organized, but what methods are used to teach the material in those courses.

The goal of this part of the project was to answer the following research questions:

2a. What numbers of allopathic medical schools in the United States have undergone any major curricular reform within the last 10 years (since 2007), and how does that compare to previous decades?

2b. What were the medical schools' stated reasons for curricular reform at their institutions?

3. How are anatomical science classes organized within medical school curricula that have been recently revised?

3a. Does the content coverage increase, decrease or stay the same for classes involving the anatomical sciences?

3b. How does the curricular revision change the amount of lab experience and type of lab experience in the anatomical sciences?

3c. How does the curricular revision change the lecture experience in the anatomical sciences?

3d. What are faculty perceptions of curricular reform at their institution?

The data collected and analyzed via surveys and interviews of the faculty members provided valuable information on the impact the curricular reform has had on both the specific anatomical science courses and on the faculty perceptions of the changes to the curriculum. The analysis of the faculty surveys showed that most respondents stated that their medical school had undergone curricular reform in the last ten years. Additionally, the primary reason that a medical school underwent curricular reform was to keep up with the current trend of curricular reform. This was also found in the analysis of the faculty interviews, with one of the codes showing the competition with other medical schools is a key feature of a medical curriculum. The surveys also showed that faculty did not have as much input into the planning and implementation of the curricular reform as the administration did. This finding also is reinforced by the interviews, with the theme "There exists an overall administrative control of the medical curriculum" from the data.

For the specific anatomical science courses of gross anatomy, microscopic anatomy, and neuroanatomy, the primary change was that they were incorporated into systems-based courses. In the lecture, many active-learning strategies were used, in addition to didactic learning. Both the amount of time and number of topics were reduced in those courses; however, the number of hours were reduced to a greater extent than the number of topics. The faculty interviews also stated how greatly the number of hours in those courses were reduced, though the level of detail in the teaching of those subjects was the area that was primarily minimized.

Faculty had some general positive perceptions about curricular reform. They stated that the integration of the material was a positive aspect of the curricular reform, especially the integration of basic and clinical sciences. This integration allowed for medical students to make more meaningful connections among the material they were learning and later implementing in the clinical workplace. Faculty also stated how they enjoyed the active learning components of the courses. While it can undoubtedly be a difficult change to transition from completely didactic lectures in the classroom to more TBLs, PBLs, flipped classrooms, etc. faculty were supportive of these newer strategies to teach information to the students.

Faculty perceptions correlated with the extent that they were involved with the planning and implementation of the curriculum. This statistic was further reinforced by faculty opinions about the need for greater communication between the faculty and the administration.

However, there were some very negative perceptions of the curriculum by the faculty whose medical schools had undergone recent curricular reform, compared to those whose medical schools had not undergone curricular reform. Results from this research, using Mann-Whitney U and Kruskal Wallis tests, showed that faculty whose medical school had undergone curricular reform do not believe their students are receiving adequate instruction of anatomical science material. This sentiment was especially true for gross anatomy organized around organ systems, as opposed to being taught as a stand-alone course. Further analysis needs to be conducted for why faculty feel this way. Is it that course hours are reduced to such an extreme extent? Is it that the administration (who are not experts in the basic science fields) has too much control of the curriculum? Could it be something else? This research did not go into that depth to answer these questions, but there was a trend of medical schools that have undergone recent curricular reform having these sentiments about their curriculum.

Despite these feelings about their medical curriculum, overall, faculty stated how their medical students were still doing as well as they had been in the past on their board examinations. Multiple studies reviewed examination scores (Cuddy et al., 2013; Hecker and Violato, 2009; Heiman et al., 2018) and found similar results: that students will do what they need to do in order to succeed in medical school, despite the curriculum that their medical school follows. Though, again, there was an association between undergoing curricular reform and negative sentiments about students receiving adequate anatomical knowledge in the curriculum. If students are doing well on their board exams despite the curricular change, what is there to worry about? Retention of anatomical knowledge may be a concern of faculty, as it's also a concern of medical education researchers (Jurjus et al., 2014; Malau-Aduli et al., 2013). The author did not look at retention of basic science material in medical students; however she acknowledges this is an important aspect of medical curricular reform. This concept is further discussed in Chapter 7.

The next chapter (Chapter 6) examines in detail how one specific medical school was impacted by curricular reform, and what impact this curricular reform had on the teaching of the anatomical sciences. The next chapter presents a case study conducted at

Indiana University School of Medicine-Bloomington campus, including the perceptions from both anatomical science faculty and first-year medical students.

CHAPTER 6: A CASE STUDY AT INDIANA UNIVERSITY SCHOOL OF MEDICINE-BLOOMINGTON

Now that the general view of the curriculum from information from anatomical science faculty and websites of allopathic medical schools in the United States is known, the author presents how the medical curriculum at one allopathic medical school has changed due to curricular reform, and how that change has impacted both the anatomical science faculty and the first-year medical students within that curriculum.

This chapter presents a case study of curricular reform from Indiana University School of Medicine-Bloomington (IUSM-B). The author first discusses the changes that occurred to the general IUSM curriculum and specifically examines how that curricular reform impacted the existing anatomical science courses. Next, the author presents both anatomical science faculty and first-year medical student perceptions about this curricular change. It is the hope of this section of the research to gain a more in-depth understanding about how one specific curricular reform has impacted the teaching and learning of the anatomical sciences.

This chapter addresses the following research questions:

Research Question 4: What are medical student and faculty perceptions of curricular reform at a case study institution (Indiana University School of Medicine-Bloomington), and how do they compare to the US landscape?

- **a.** How do first-year medical students at IUSM-B perceive the newly implemented medical curriculum that began in fall 2016?
- **b.** How do anatomy faculty perceptions of curricular reform at IUSM-B compare to anatomy faculty perceptions from other US medical schools?

Methodology

The specific methods for this part of the research are discussed in length in Chapter 3, and they are briefly reviewed here.

Curricular Change at Indiana University School of Medicine-Bloomington (IUSM-B)

The author gathered information from IUSM-B about the curricular reform that occurred at the institution in fall 2016, including the following sources of data:

- curricular information from the IUSM website,
- a 62-page document from the IUSM Statewide Anatomy Retreat, which occurs every year with anatomy faculty from all campuses of IUSM, and
- syllabi from the anatomical science courses taught in the new curriculum

IUSM-B Student Survey

The author created a survey which was distributed to medical students who had completed the first year of the pre-clerkship curriculum at IUSM-B. The survey was distributed in the summer of 2017 and the summer of 2018. The invitation was sent to students after they had finished their first year of medical school, and before they began their second year. Only first-year students from IUSM-B were chosen to partake in the survey since the anatomical basic science courses are taught in the first year of the medical program at that school.

The complete survey may be seen in Appendix D. Questions from the student survey included both quantitative and qualitative, open ended questions. The quantitative questions that were asked on the survey included the following:

- <u>Yes or no question</u> about whether the students were told about curricular reform during their IUSM medical school interview

- Likert Scale perception questions on a 1-5 scale about satisfaction of time dedicated to the three anatomical disciplines, if they felt rushed learning the material, how they liked the integration of gross and microscopic anatomy, and if they felt the curriculum prepared them for the NBME exams. The 1-5 scale values will be different depending on the question. Each 1-5 scale is explained in this chapter.
- Question about overall satisfaction with the curriculum, on a 1-10 scale (1 = not at all satisfied with curriculum to 10 = extremely satisfied with curriculum)
- Open-ended questions about what students like and dislike about the curriculum and any constructive suggestions they have to improve to curriculum. There were 3 of these questions.

The entire population of first-year medical students at IUSM-B were surveyed by using **purposeful total population sampling**, or TPS (Etikan et al., 2016). This type of sampling is where the entire population that meet a certain criterion (e.g., first-year medical students at IUSM-B) are included in the research.

Survey data from the medical students were collected until September 2018. Data were then compiled into a spreadsheet (Excel, 2016) and then analyzed using IBM Statistical Package for the Social Sciences (SPSS) Statistics Version 23 (IBM Corp., 2013). Only descriptive statistics and frequencies were used to analyze the quantitative data because of the lower student population size compared to the faculty survey respondents. Additionally, there were no obvious questions for comparison with the medical student survey as there were with the faculty survey presented in Chapter 5 (i.e., the comparison of perceptions of faculty whose medical school had undergone curricular reform versus those whose medical school had not undergone curricular reform).

MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used with the qualitative open-ended survey. **Content analysis** of the data was used. Content analysis involved reading through the data multiple times to generate meaning and create codes and sub codes from the faculty responses. The author first read through every answer to the question, and then she wrote down general patterns of the data, which may have been a code or sub code. If there were many similar patterns, then the author deemed them to be sub codes and created a general code for those similar sub codes. In order not to miss any codes or sub codes, the author then read through the data again and tried to find any additional terms that could be used in order to organize that data. Finally, after the author deemed the coding process completed, the number of codes and sub codes were tallied and are presented below along with select quotes from the student surveys. The student responses to the open-ended questions could be coded into more than one code or sub code, depending on the context of the response. Only the excerpt from the response that involved the specific sub-code or code was included within the tables found in this section. The codebook for the data may be seen in Appendix I.

IUSM-B Student Focus Group

IUSM-B students who had matriculated in fall 2016 and who had completed their first year of the medical program had the option of participating in a focus group session about their experiences with the curricular reform. The students could participate in this session whether or not they had completed the survey.

The author had the option of collecting data for another cohort – those who matriculated in fall 2017, but due to time constraints, a second focus group of the fall 2017 students did not occur.

Focus group data was collected in August of 2017. The August collection date, which happened to coincide with when the students entered their second year of medical school, was chosen to optimize the sample size and not interfere with the timing of exams (such as the Neuroscience NBME exam which is given on the last day of class in the first year). Thus, the type of sampling method employed was convenience sampling, which is discussed in Chapter 3.

During the focus group, the author passed out name tags with numbers written on them, and that served as the only identifying feature, so that the author could keep track in her notes about who was saying what. The session lasted for approximately one hour, after which the author thanked the students for participating.

A list of questions that were asked of the participants in the focus group is in Appendix E. This focus group used a semi-structured interview approach, by which the author had a set list of questions to ask the group, but at times the author would allow the conversation to deviate from some of the topics and explore topics that were not on the interview sheet. The general questions included inquiring about what the students were told about the new curriculum, how they felt about the amount of time dedicated to the anatomical sciences in their courses, and the extent to which they believe the courses and instructors prepared them for their examinations. The session, which lasted around one hour, was recorded using a digital recording device, and the author took notes on the important aspects of the conversation, utilizing the numbers on the participants' name tags for identification. Transcription of the data was completed with the help of Dragon NaturallySpeaking Software, Version 15 (Nuance Communications, 2018).

For the analysis of the data, MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used. Thematic analysis was used to analyze the focus group data. Thematic analysis is a type of qualitative analysis that involves searching for recurring ideas (or themes) in the data, after all data is collected. This type of analysis allows for a rich and deep understanding of the data to discover patterns and develop themes (Jason and Glenwick, 2016). During the analysis of the data, the author primarily used a deductive approach with a priori codes discovered from literature on the subject, seen in Chapter 2 under the *Medical Education Reform and the Anatomical Sciences* section. This deductive approach was then followed by an inductive approach. The codebook for the data may be seen in Appendix J.

IUSM-B Anatomical Science Faculty Focus Group

A semi-structured interview with faculty members who teach in the anatomical sciences at IUSM-B was conducted in August of 2017. This focus group consisted of inviting those faculty members to a discussion of the curriculum after a normal meeting where they were already present.

A list of questions that were asked of the focus group may be seen in Appendix F. The general questions that were asked included inquiring about what led to the need for curricular reform at IUSM-B, gaining insight on how faculty perceived working with others in the courses they taught as well as with faculty from different campuses, and asking how well the faculty believed the students were doing as a result of the curricular reform.

The focus group was guided by steps outlined by Krueger and Casey (2002) described above under the *Student Focus Group* section. Transcription of the data was completed with the help of Dragon NaturallySpeaking Software, Version 15 (Nuance Communications, 2018). For the analysis of the data, MAXQDA software, Version 12 (VERBI Software Consult, 2018) was used. A thematic analysis approach was used for this focus group data as well.

Case Study of Curricular Change at IUSM-B

Chapter 5 highlighted a common reason a medical school had undergone curricular reform was to prepare for reaccreditation by the LCME. This reason also applied to Indiana University School of Medicine, which underwent curricular reform in August of 2016. An LCME survey team had visited IUSM in November of 2008 and had found IUSM to be “in partial or substantial noncompliance with key standards” (IUSM, 2015, pg. 12). Some of these standards in which IUSM had issues with compliance included a few related to the clinical clerkships, such as the amount of observations of students’ clinical skills, but the majority of the complaints arose from the general format of the curriculum. After that visit, LCME stated that there was not enough horizontal and vertical integration in the curriculum. Additionally, the LCME stated that there was too much time devoted to lecture and not enough time dedicated to independent learning. A final criticism was that the campuses were not standardized enough.

IUSM consists of nine campuses spread throughout the state of Indiana. They include (in alphabetical order) Bloomington, Evansville, Fort Wayne, Indianapolis, Muncie, Northwest (Gary), South Bend, Terre Haute, and West Lafayette. In the legacy (pre-fall 2016) curriculum at IUSM, each of the IUSM campuses taught the anatomical science courses in their own way. Some of the ways in which gross anatomy was delivered to the medical students in the legacy included a 7-week block in the first semester of the first year at the South Bend campus, a year-long course in the first year at the Bloomington campuses, and a problem-based learning (PBL) format at the Northwest campus. All other campuses taught gross anatomy as a semester long course in the fall semester of the first year of the medical program (Valerie O'Loughlin, personal communication, March 26, 2019).

For microscopic anatomy, most campuses taught this subject in the first semester of the first year. However, South Bend also taught this subject in a block format for 6 weeks in the first semester. The Northwest campus also taught this subject in a PBL format. Campuses used a wide variety of methods for the lab portion of microscopic anatomy, including optical microscopy, virtual microscopy, and PowerPoint slides (Valerie O'Loughlin, personal communication, March 26, 2019).

For neuroanatomy, most campuses taught this course in the second semester of the first year of the medical program. South Bend taught neuroscience for 7 weeks. Muncie taught it for 5 weeks. The Northwest campus again had a PBL format. Bloomington, Fort Wayne, West Lafayette, Evansville, and Terre Haute taught it for a full semester in the second semester of the first year. However, the Indianapolis campus taught it in the first semester of the second year.

For assessment measures, most campuses created and delivered their own examinations and other assessment measures (presentations, gross anatomy lab dissections, etc.). At the end of each course, the medical students took a state-wide National Board of Medical Examiners (NBME) final. This final was the same across all campuses and delivered to the medical students at the same time. The Northwest campuses was the only campus not to have additional assessment measures. The majority of the students' grade was reliant upon how they did on their NBME exam (Valerie O'Loughlin, personal communication, March 26, 2019).

In order to address and review the issues of consistency, Dr. Dan Hunt, co-secretariat of the LCME, met with administrators from IUSM in 2009 to review these non-compliant standards, and he made recommendations to the university on how to meet these standards. Dr. Hunt recommended, in order to create a sense of collaboration among the nine IUSM campuses, to remove the term "regional campuses" and replace it with "partner campuses." Additional recommendations to standardize the campuses included using additional common assessments – more than the NBME comprehensive final examination assessments. Other recommendations included increasing small group learning to approximately 50% of class time, thus reducing lectures to only 50%, (IUSM, 2015).

As was mentioned in Chapter 2, the LCME performs site visits every eight years (LCME, 2018), so IUSM had approximately eight years to revise its curriculum so it aligned with the LCME standards in preparation for the next site visit in 2016/2017. During this time, IUSM changed many aspects of its curriculum, and those major changes are outlined below. However, since this dissertation specifically focuses on the anatomical sciences, the changes to gross, microscopic and neuroanatomy are discussed, with a lesser focus on the other basic sciences and clerkship years of the curriculum.

Comparisons Between the IUSM Legacy Curriculum and Revised Curriculum

One way to facilitate integrating the curriculum was to combine many of the courses. Prior to fall 2016, most IUSM courses were taught separately, as discipline-based courses. Gross anatomy, microscopic anatomy (cell biology), and neuroscience were all stand-alone courses. Beginning in fall 2016, with the implementation of curricular reform, many courses were partially or totally combined with either other courses or other disciplines. Specifically, for the anatomical science courses, gross anatomy, embryology, microscopic anatomy, and some radiology were integrated into a course entitled Human Structure. The content from the one-semester neuroscience course was integrated with neurophysiology, neuroembryology, neuropharmacology, neurology, psychiatry and neuropathology, to create a new course entitled Neuroscience and Behavior.

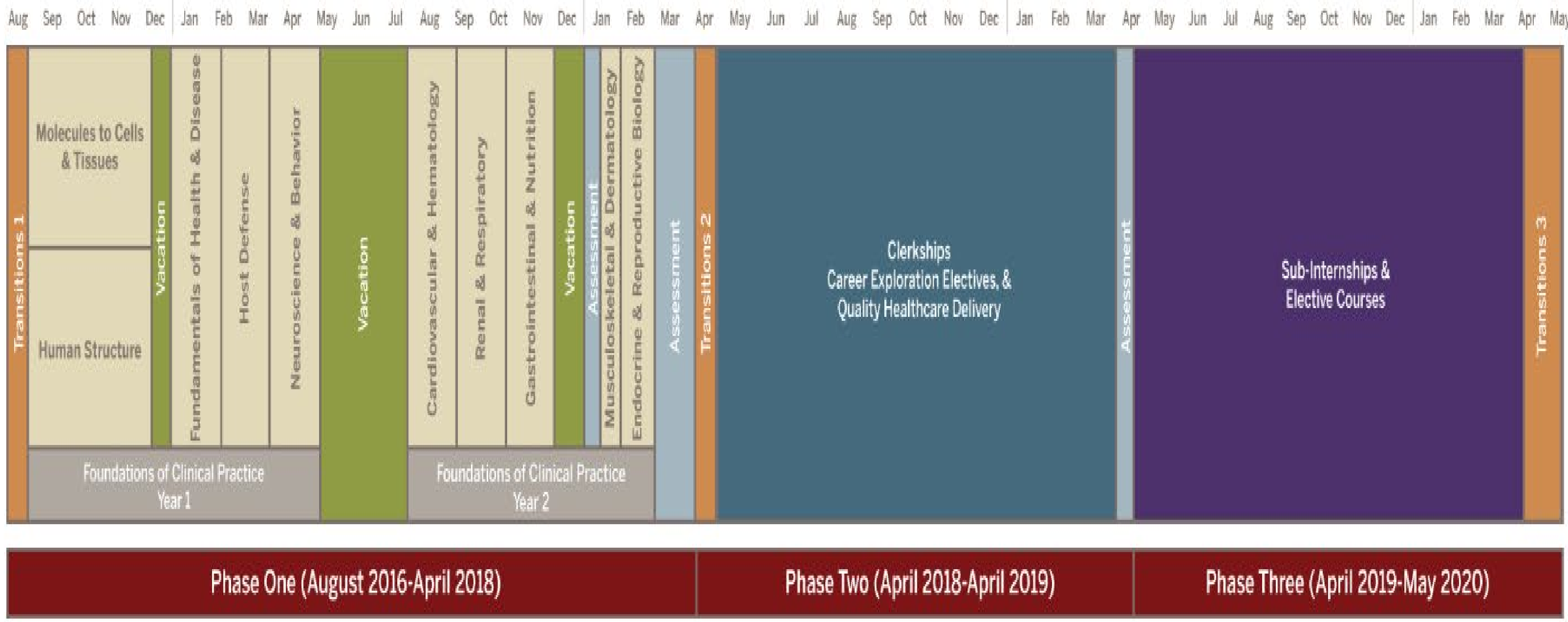
Figure 6.1 shows a curricular map for all four years of the new curriculum at IUSM. This map is an interactive one, by which one can click on features of the map and another box will pop up that discuss aspects of the curriculum (IUSM, 2019). Chapter 4 stated how more schools should create an interactive curricular map, and IUSM has done so. The new curriculum is split into three phases (IUSM, 2018):

- Phase 1 encompasses the first two years of the medical curriculum, when the basic science courses are taught. There is a focus of integration of foundational medical knowledge with clinical skills in this Phase.
- Phase 2 begins year three of the medical program, after the students take their Step 1 board examination (USMLE Exam, Step 1). This Phase is dedicated to having the students develop their clinical skills through training in clinical clerkships.
- Phase 3 is the last part of the medical program, where students have the ability to explore their career options through electives.

At the beginning of medical school and in between the different phases of the curriculum, there are a total of three Transitions courses. These courses serve as a course to bridge in between the phases (IUSM, 2018).

- Transitions I is taken before the medical students begin their first-year coursework. This course is two weeks in length, and it helps to instruct medical students in ethical principles in medicine, disparities in health care delivery, patient safety, communication skills, and utilizing evidence-based medicine for clinical practice.
- Transitions II is a two-week course taught prior to the beginning of Phase 2. Transitions II builds upon the foundations learned in Transitions I to help students develop skills to become part of a medical team.
- Transitions III is taught at the end of Phase 3, prior to the medical students entering their residencies. This course serves as a comprehensive preparation for residency.

Figure 6.1: New Curricular Map for IUSM for class of 2020



This curricular map shows the three phases of the new (post fall-2016) curriculum at IUSM.

Legacy Curriculum: Anatomical Sciences at IUSM-B

In the legacy (pre-fall 2016) medical curriculum at IUSM-B, Human Gross Anatomy was a year-long course, taught in the fall and spring semesters of the first year of the medical program. This course was 8 credit hours and included 115 contact hours, including lab and lecture. Embryology and some radiology were also incorporated with gross anatomy. There were six blocks of information, and students had thirteen total examinations over that information, from both lecture and lab examinations, and a final comprehensive examination. For each block examination, students took an exam over the information learned in lecture, and then afterwards they had a written practical examination over the lab material. The lecture examinations ranged from 80-100 points and included multiple choice, matching, and short answer/essay questions. The lab examinations ranged from 80-100 points and asked for correct identification of structures on donors, medical images, models, and bones. There were also higher order, application-based questions on the lab practical. Additionally, there was a National Board of Medical Examiners (NBME) comprehensive final exam at the end of the year, which was worth 20% of the student's grade. This course also had additional assessments which counted toward the final grade, including daily lecture quizzes, and a dissection grade on the donor dissection of the upper and lower limbs (IUSM-B, 2015-2016).

Microscopic anatomy at IUSM-B was a semester-long course entitled Cell Biology and Histology and was taught in the fall semester of the first year. This course was 4 credit hours and included 60 contact hours, including lab and lecture. Students had three blocks of information and seven total examinations, from both lecture and lab examinations, and a final comprehensive examination. The lecture examinations were multiple choice, and the lab examinations were fill in the blank. Each block of lecture and lab exams was worth 75 points. At the end of the fall semester, students took an NBME comprehensive final examination, worth 20% of the student's grade. Additional assessments which counted toward the student's final grade included occasional pop quizzes, a flipped classroom learning experience, and a group project (IUSM-B, 2015-2016).

The Medical Neuroscience course in the legacy curriculum was a semester-long course taught in the second semester of the first year of the medical program at IUSM-B. This course was 5 credit hours and had 65 contact hours, including lab and lecture. This course consisted of three blocks of material and six examinations, one lecture and laboratory examination for each block. Each lecture examination was worth 100 points, and each lab examination was worth 40 points. The lecture examinations were multiple choice, and the lab examinations were a practical examination where students had to identify structures on specimens, virtual images, and radiographic images. Students had an NBME comprehensive final examination at the end of the semester, which was worth 20% of the final grade. Additional assessments which counted toward the student's final grade included daily quizzes, answering online questions, and a clinical case presentation (IUSM-B, 2015-2016).

Revised Curriculum at IUSM – Exam Consistency

In the legacy curriculum, course examinations were prepared by each campus' course director and could potentially vary greatly from campus to campus. In the new medical curriculum, common examinations are given to students at all 9 campuses. The development of these examinations is a team effort of the statewide course director for the course in question (e.g., Human Structure) and the course directors and faculty who teach that course at a particular campus (e.g., IUSM-B). The statewide director and campus course directors meet and give edits and comments to the questions, such as making sure that the session learning objectives are covered by the questions (Valerie O'Loughlin, personal communication, January 17, 2019). These meetings are conducted either face to face or online through Zoom, a video conferencing service (Zoom, 2019). All medical students from each campus will take the same examinations at the same time of day.

Revised Curriculum at IUSM – Course Integration and Consistency

In the current curriculum at IUSM, Human Structure is a semester-long course taught in the first semester of the medical program. The course integrates gross anatomy, microscopic anatomy, embryology, and radiology. It is a 9-credit hour course with 160 contact hours. In general, 60% of the time is spent on gross anatomy information (including embryology and radiology), with the other 40% on microscopic anatomy information. There are four blocks of information during the semester. Faculty and clinical instructors who teach Human Structure (and the other courses in the revised curriculum) teach similar content and use the same Session Learning Objectives (SLOs) and Course Learning Objectives (CLOs) across campuses. An example of an SLO from the Superior, Middle and Posterior Mediastinum and Heart lecture from Human Structure is as follows:

> "Describe the orientation, borders, surfaces, and surface projection of the heart in situ and briefly correlate these relationships to x-ray views of the heart."

Instructors from the different campuses have some freedom about what day the teach the material, with the understanding that at the end of each block, all students from each campuses will be tested on the same material. While the scheduling might be different from campus to campus, students have access to the recorded lectures from all nine campuses.

The medical students across all campuses take written and practical examinations on each block of material in Human Structure, and there are four separate blocks. While the written examinations are the same for each medical student, the practical examinations are not. Those examinations should be somewhat consistent, but because of practical constraints such as the types of models in the classroom and structures found on the donors, it is impossible to make the entire examination consistent across each campus. The written examination for Human Structure is completed on the students' computers through ExamSoft software (ExamSoft, Worldwide, Inc.) and consists of 80 multiple choice questions, in the style of NMBE exam questions. There is an imaging examination over radiology and histology images, which consists of 40 multiple choice questions. Finally, there is a gross anatomy lab practical which is very similar to how the lab practical was run in the legacy curriculum. In addition to the 4 sets of block exams, there is also a final comprehensive NBME examination, which covers gross anatomy (55%), microscopic anatomy (35%), and embryology (10%) topics. This final examination is worth 20% of the final grade (IUSM-B, 2018-2019).

In the legacy curriculum, within the Cell Biology and Histology course, medical students had a histology lab associated with each lecture, where they would review the important structures they needed to know for their lab exams. This practice continued only in the first year of the revised curriculum. Starting in fall 2017, medical students are now expected to complete most of their histology lab modules out of class. The students do have an in-class lab on one of the first days to instruct them in how to navigate the virtual microscopy system, and they also have a mandatory in-class practice exam before the block exam, but, otherwise, the students complete the modules themselves (IUSM-B, 2018-2019).

There are several notable differences between the Medical Neuroscience course from the legacy curriculum and the Neuroscience and Behavior course from the revised curriculum. First, the length of the course in the revised curriculum is much shorter. This course is only six weeks in length and is taught in the last six weeks of the first year of the medical program (approximately early April until mid-May). Second, the revised course covers the topics of neuroanatomy, neuropharmacology, neurophysiology, and psychiatry. This contrasts with Medical Neuroscience only having covered neuroanatomy and neurophysiology. Third, the number of lecturers involved with the Neuroscience and Behavior course includes many more clinical instructors than did the Medical Neuroscience course. At IUSM-B, the Neuroscience and Behavior course has one primary faculty lecturer who serves as the course director and 20 other clinical lecturers who discuss certain topics throughout the six-week course. This contrasts with only one instructor who taught in the Medical Neuroscience course at IUSM-B. Finally, the assessments for the revised course are different than the assessments from the legacy course. There are three blocks of material in the Neuroscience and Behavior course, with a corresponding examination for each block. The first two exams are each worth 26% of the final grade and include multiple choice questions related to both lecture and lab information learned in the class. Questions related to information from the labs include identification of structures on digital images of gross specimens); myelin-stained sections of whole brains, brainstems, and spinal cords; and radiographic images. The block three examination does not cover information learned in the lab portion of the course and is worth 21% of the entire grade. These examinations are completed on student computers using ExamSoft (ExamSoft, Worldwide, Inc.). Students take a final comprehensive NBME examination at the end of the semester which is worth 27% of the entire grade (IUSM-B, 2018-2019). Please see the paragraph above about how the assessments in the Medical Neuroscience course at IUSM-B were given.

Revised Curriculum at IUSM – Grading Policies

Another aspect of the curriculum that has drastically changed is the grading system. In the legacy curriculum, students typically had to receive at least a 65-70% to pass a course. Additionally, students would be placed into one of four categories based on their grades and how their grades compared with the rest of the students in the course. Table 6.1 displays the grading system prior to the curricular reform in fall 2016. An "Honors" distinction was the highest a medical student could achieve in his or her course, but only 10-20% of the medical students were awarded that distinction. Most students received the "High Pass" (30-50%) or the "Pass" (40-60%) distinctions. If a student received below 70% in the course, he or she received a "Fail" distinction. If the student failed, he or she would have to take an NBME statewide examination during the summer and pass it with a score of 70% of higher (IUSM-B, 2015-2016).

Table 6.1: Evaluation and Grading Policies for Legacy IUSM Curriculum

Distinction	Percentage of Class Receiving that Distinction
Honors (H)	10-20%
High Pass (HP)	30-50%
Pass (P)	40-60%
Fail (F)	0-5%

In the new curriculum at IUSM, the grading system moved to a pass/fail grading system. Students receive a passing grade based on two criteria: by being within or above 2 standard deviations of the statewide class mean on the total of all assessments given in this course, and by scoring within or above 2 standard deviations of the statewide class mean on the NBME Final exam for that semester. This 2 standard deviation cutoff may vary from year to year and from course to course, but for the anatomical sciences, typically the cutoff has been below the 70% cutoff of the legacy curriculum. Failure to meet either of these criteria may result in failure of the course.

If a student fails the course, most times, the student may remediate the course materials and pass a comprehensive exam (either another NBME exam or a separate comprehensive exam). The pass cutoff for remediation is 70%. If the student does not meet the passing requirements of this remediation, he or she may have to repeat the academic year in its entirety (IUSM, 2018 and IUSM, 2019).

Additional differences between the new and the legacy medical curriculum at IUSM include a focus on active learning in the classroom. As mentioned above, to meet one of the LCME standards, the medical curriculum needed to have no more than 50% of the time spent on didactic lectures, leaving around 50% of the time for small group learning. Some common active learning activities utilized in the curriculum include problem-based learning, team-based learning, and case-based learning (IUSM-B, 2018-2019). Further, there is one self-directed learning session in the Human Structure course, where students are expected to present upon a certain topic by identifying, analyzing, and synthesizing information while assessing the credibility of resources (IUSM-B, 2018-

2019) This self-directed learning activity assesses one of the competencies of the medical program, which is for the medical students to

> "engage in self-directed learning by identifying gaps and limitations in current knowledge and performance; setting individual learning and improvement goals; identifying multiple information resources to achieve those goals; critically appraising the quality and credibility of information resources used; and synthesizing relevant information to advance medical knowledge and patient care" (IUSM, 2018).

Table 6.2 illustrates some of the differences in the competencies from the legacy curriculum to the new curriculum at IUSM, using the comparisons of IUSM-B's Human Gross Anatomy course from the legacy curriculum and IUSM's Human Structure course in the new curriculum. In the legacy curriculum, the competencies were divided into nine categories: Communication and Interpersonal Skills; Basic Clinical Skills; Using Science to Guide Diagnosis, Management, Therapeutics, and Prevention; Lifelong Learning; Self-Awareness, Self-Care and Personal Growth; Social and Community Context of Healthcare; Moral Reasoning and Ethical Judgment; Problem Solving; and Professionalism and Role Recognition (Humbert, 2014).

For the Gross Human Anatomy course, the medical students were assessed on five of those competencies. For the Communication and Interpersonal Skills competency, the students were required to complete a team-based learning (TBL) activity and effectively interact with their peers and instructors. For the Lifelong Learning competency, students were required to actively participate in lab and lecture, including a TBL activity. For the Self-awareness, Self-care, and Personal Growth competency, students needed to fill out a questionnaire about their experiences with the donors in the gross anatomy lab. The Professionalism and Role Recognition competency required students to behave in a professional manner in their lecture and lab activities, especially when interacting with the donors in lab. Finally, for the Basic Clinical Skills competency, the students were required to learn to evaluate x-rays, CT scans, MR images and integrate these radiological techniques with anatomical structure; additionally, they were required to complete a Donor Report on their donor, detailing what pathologies they found and what their experiences were while dissecting the donors (IUSM, 2015-2016). As long as the students completed the above tasks, they passed the competency portion of the curriculum. There was no formal rubric for those competencies, unlike the one for the competencies in the new curriculum.

The revised curriculum has six competencies (Medical Knowledge, Patient Care, Practice-Based Learning and Improvement, Interpersonal Skills and Communication, Professionalism, and Systems-Based Practice) and associated objectives. The objectives are then devised to be course specific. For example, for the Medical Knowledge (MK) competency, one objective (referred to as MK1) is

> "Apply knowledge of normal human structure, function and development, from the molecular through whole body levels, to distinguish health from disease and explain how physiologic mechanisms are integrated and regulated in the body."

The course objective for this competency and associated objective specific to Human Structure is "Describe the embryology of organ systems and the developmental abnormalities that lead to common congenital defects" (IUSM, 2018).

Not every medical course in the new curriculum assesses each competency. Please see Table 6.2 which shows the course objectives for the Human Structure course.

Table 6.2: Comparison of Competencies assessed in IUSM-B Gross Human Anatomy (legacy curriculum) and Human Structure (new curriculum)

Competencies assessed in the IUSM-B Gross Human Anatomy course[1]	Competencies and Course Learning Objectives from New Curriculum (Human Structure)[2]
Communication and Interpersonal Skills • Effective Communication is evaluated by: (l) successfully completing the TBL and (2) examining oral communication on a one-to-one basis as students interact with each other and respond to faculty questions in the laboratory. **Lifelong Learning** • Lifelong Learning is addressed by: (1) active participation in lab and lecture activities and (2) completing the TBL exercise. **Self-Awareness, Self-Care and Personal Growth** • Self-awareness, Self-care, and Personal Growth are assessed by completing a questionnaire examining the student's attitude toward the donors (cadavers) **Professionalism and Role Recognition** • Professionalism and Role Recognition are evaluated by (1) observing students' attitudes regarding teamwork in their dissection groups and in their TBL, (2) completion of the individual limb dissection, and (3) completing the Gross Anatomy Laboratory Experience Questionnaire.	**Medical Knowledge (MK) Competency** • MK1 — Describe the embryology of organ systems and the developmental abnormalities that lead to common congenital defects. • MK1 — Demonstrate knowledge of the structural and functional organization of the adult human body and its variations as visualized by direct dissection of human cadavers and by medical imaging techniques. • MK1— Identify the histology and electron microscopic morphology of tissues and organs through the use of light and electron microscopy and discuss the functional aspects of the identified tissues. **Practice-Based Learning and Improvement (PBLI) Competency** • PBLI1 — Identify gaps in their understanding of the developmental, histologic, and gross anatomic structure of the human body; locate, analyze, and appraise information to overcome their knowledge deficits; and integrate new information to broaden their foundation of medical knowledge. **Professionalism (P) Competency** • P2 — Demonstrate professionalism through respect for the donor, the medical education process, and their peers.

Basic Clinical Skills • Basic Clinical Skills are assessed by (1) learning to evaluate x-rays, CT scans, MR images and integrating these radiological techniques with anatomical structure and (2) completing a Donor Report (autopsy report) based on the dissection of your donor. The Donor Report can be downloaded from the A550 website.	

[1] Example of how selected competencies were assessed/discussed for one campus in old curriculum. Not all competencies were same across all campuses

[2] All Human Structure courses at all campuses assess same competencies

In the new curriculum at IUSM, competencies are assessed through two different means. The Medical Knowledge course learning objectives are assessed through the pass/fail grading system which was discussed above. The other two categories of Problem-Based Learning and Improvement and Professionalism are also assessed on a pass/fail basis. Student's professionalism is assessed twice during the semester using an assessment rubric. Tables 6.3a and 6.3b show how the competencies of Problem-Based Learning and Improvement and Professionalism are assessed. If a student receives a zero on more than two areas of the rubric, then the student must complete remedial work in the designated competency to pass the educational experience (IUSM, 2019).

Table 6.3a: Rubric for Problem-Based Learning and Improvement Assessment

SDL PBLI Assignment Rubric

Criteria	Ratings		Pts
Provides examples of specific strengths and gaps in their knowledgebase.	1 pts Yes	0 pts No	1 pts
Provides an explanation for how they determined their learning needs and how they went about addressing their learning needs.	1 pts Yes	0 pts No	1 pts
Provides a list of key resources used to address learning gaps in knowledge and understanding of anatomy/histology content.	1 pts Yes	0 pts No	1 pts
Provides an assessment and explanation of their confidence level and anticipated performance on Exam 1.	1 pts Yes	0 pts No	1 pts
Reflects on the impact of the laboratory process and peer interactions on their learning.	1 pts Yes	0 pts No	1 pts
Provides a credible analysis of their performance on Exam 1.	1 pts Yes	0 pts No	1 pts
Provides an appropriate approach, including and revision, to preparation for Exam 2.	1 pts Yes	0 pts No	1 pts
Demonstrates discernment in evaluating learning resource quality.	1 pts Yes	0 pts No	1 pts
			Total Points: 8

Table 6.3b: Rubric for Professionalism Assessment

Professionalism Assessment			
Criteria	**Ratings**		**Pts**
Prepares for small group and/or lab activities.	1.0 pts Yes	0.0 pts No	1.0 pts
Submits assignments on time.	1.0 pts Yes	0.0 pts No	1.0 pts
Assumes responsibility and is dependable.	1.0 pts Yes	0.0 pts No	1.0 pts
Notifies group in advance of expected absences.	1.0 pts Yes	0.0 pts No	1.0 pts
Accepts feedback and incorporates it to improve performance.	1.0 pts Yes	0.0 pts No	1.0 pts
Demonstrates respect toward peers and faculty.	1.0 pts Yes	0.0 pts No	1.0 pts
Demonstrates integrity and honesty.	1.0 pts Yes	0.0 pts No	1.0 pts
			Total Points: 7.0

After IUSM began the new curriculum in fall 2016, an LCME survey team visited the medical school, concluded on April 23, 2017. With the LCME visit, the team felt that IUSM was moving towards consistency in learning experiences across all centers and there was a focus toward integration with the new curriculum. The LCME then granted IUSM full accreditation through 2024-2025 (IUSM, 2018).

Quantitative Data Analysis of IUSM-B Student Survey

Twenty (20) of the 36 medical students from the first cohort (matriculation date of 2016) responded to the survey, but only six (6) of the 36 medical students from the second cohort (matriculation date of 2017) responded. This sample size remained small even after the author contacted the medical students multiple times requesting their participation in the survey. The sample size represented 36% of the total student population (72) for the study. The first cohort of medical students who responded to this survey were the first group to have gone through the curricular reform. The second cohort of students who responded to this survey were then the next group to have gone through the new curriculum.

Of the twenty-six (26) students who responded to the survey, twenty-two (22; 84.6%) stated they were told during their medical school interviews that the IUSM curriculum would have a different type of curriculum compared to years past, compared to four (4; 15.4%) who stated they were not told. All six (6) of the second cohort of students stated that they were told about the new type of curriculum during their interviews. It is possible that all medical students from both cohorts were told of the curricular reform during the interview, but that those four students who answered “no” did not remember they were told so.

The next survey question asked how satisfied the medical students were with the amount of time dedicated to the teaching of each anatomical subject (gross anatomy, microscopic anatomy, neuroanatomy) in the IUSM-B curriculum. Even though gross anatomy and microscopic anatomy were integrated in the IUSM curriculum within Human Structure, students were told to think of these subjects separately. The data set is represented in Figure 6.2. Students had the option of choosing one of the following responses to this question:

- Very dissatisfied
- Dissatisfied
- Neutral
- Satisfied
- Very satisfied

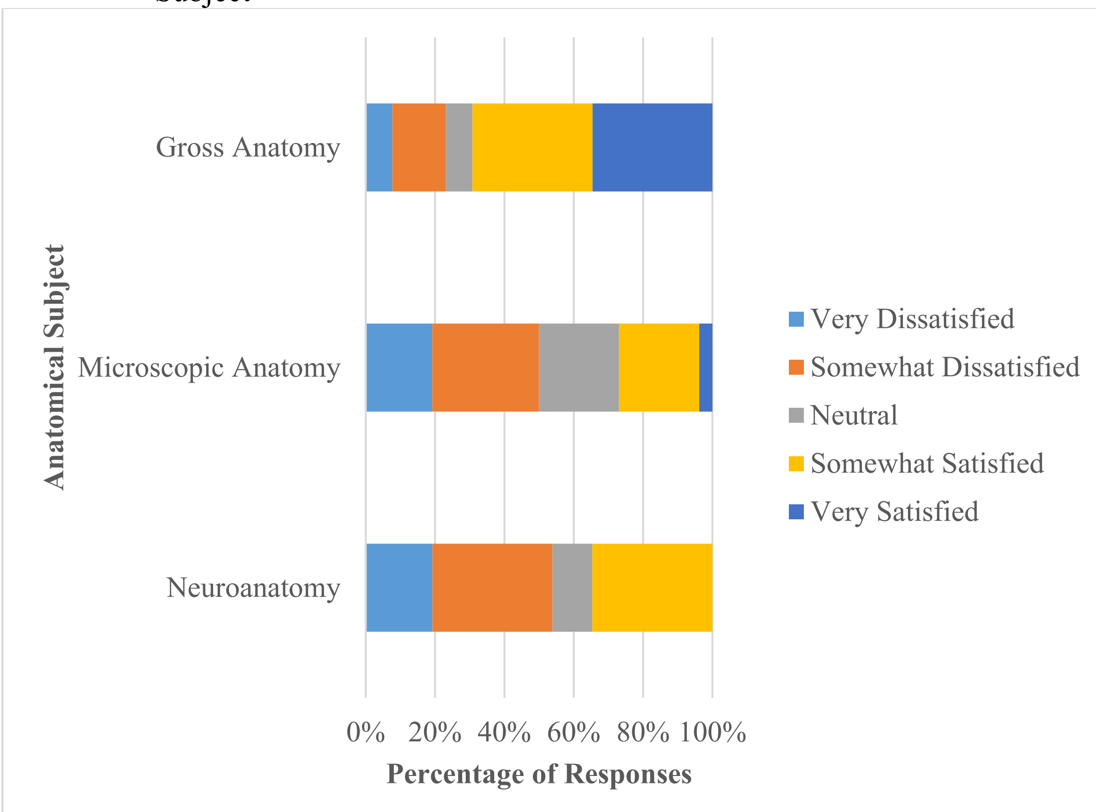
For the subject of gross anatomy, of the twenty-six students who responded to this question, 2 (7.7%) stated they were “very dissatisfied” with the amount of time dedicated to teaching gross anatomy; 4 (15.4%) stated they were “dissatisfied;” 2 (7.7%) responded “neutral;” 9 (34.6%) responded “satisfied;” and 9 (34.6%) responded “very satisfied.”

For microscopic anatomy, of the twenty-six students who responded to that question, 5 (19.2%) stated they were “strongly dissatisfied” with the amount of time dedicated to that subject; 8 students (30.8%) responded they were “dissatisfied;” 6 (23.1%) stated they were “neutral;” 6 (23.1%) stated they were “satisfied;” and 1 (3.8%) stated they were “very satisfied.”

For neuroanatomy, of the twenty-six students who responded to the question, 5 (19.2%) stated they were “strongly dissatisfied” with the amount of time dedicated to teaching that subject; 9 (34.6%) stated they were “dissatisfied;” 3 (11.5%) responded they were “neutral;” and 9 (34.6%) responded they were “satisfied.” No respondents said they were very satisfied with the amount of time dedicated to teaching neuroanatomy.

Overall, students were more satisfied with the amount of time dedicated to teaching the gross anatomy topics, compared to the amount of time for both microscopic anatomy and neuroanatomy topics. Almost 70% of students said they were “satisfied” or “very satisfied” with the amount of time dedicated to teaching gross anatomy, while 45-50% of students said they were “dissatisfied” or “very dissatisfied” with the amount of time dedicated to teaching microscopic and neuroanatomy. The gross anatomy aspect of Human Structure was very similar to how it was taught in the old curriculum at IUSM, with the organization and number of topics. However, both microscopic and neuroanatomy changed drastically, with microscopic anatomy lab almost completely eliminated (in fall 2017) and neuroanatomy reduced to a six-week course. These changes in microscopic and neuroanatomy may have contributed to more negative feelings about the amount of time dedicated to teaching those subjects. Additional open-ended responses from the medical students pertaining to these survey questions will be discussed in the next section of this chapter.

Figure 6.2: Medical Student Satisfaction with Amount of Time Dedicated to Anatomical Subject



n = 26

Most first-year medical students from IUSM-B stated they were satisfied with the amount of time dedicated to teaching gross anatomy. However, around 50% of students were dissatisfied with the amount of time dedicated to teaching both microscopic and neuroanatomy.

Figure 6.3 shows the results to the survey question which asked the medical students how rushed they felt with having to learn the information for their unit examinations. Again, gross anatomy and microscopic anatomy were considered separately for this question.

The following were options from which the students could chose as a response to this question:

- Very rushed
- Rushed
- Neutral
- Not very rushed
- Not at all rushed

Of the 26 medical students who responded to this question about gross anatomy, 8 (30.8%) said they felt “very rushed” with having to learning gross anatomy information for their unit exams; 9 (34.6%) said they felt “rushed;” 3 (11.5%) said “neutral;” and 6 (23.1%) said they felt “not very rushed.” No students stated they did not feel at all rushed with having to learning gross anatomy information for their exams.

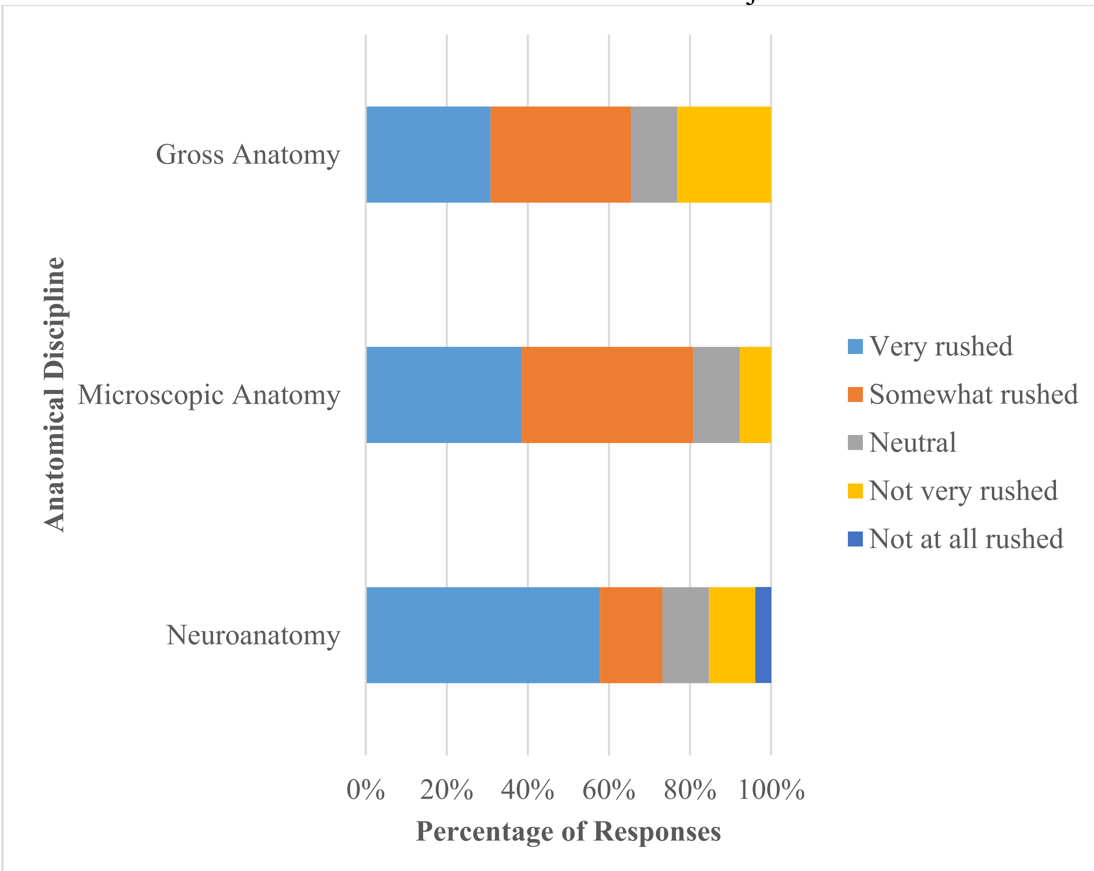
For microscopic anatomy, out of the 26 students who responded to this question, 10 (38.5%) stated they felt “very rushed” with having to learn microscopic anatomy information for their exams; 11 (42.3%) stated they felt “rushed;” 3 (11.5%) responded “neutral;” and 2 (7.7%) stated they did not feel very rushed. Similar to gross anatomy, no students answered that they did not feel rushed at all in learning microscopic anatomy information for their examinations.

For neuroanatomy, of the 26 students who responded to this question, 15 (57.7%) responded they felt “very rushed” with having to learn neuroanatomy information for their unit exams; 4 (15.4%) stated they felt “rushed;” 3 (11.5%) responded “neutral;” 3 (11.5%) responded that they felt “not very rushed;” and 1 (3.8%) responded they did not feel at all rushed.

Between 65-80% of students responded that they felt “rushed” or “very rushed” for learning each anatomical subject. In particular, students felt more rushed with learning microscopic anatomy and neuroanatomy information than they felt about gross anatomy. With the reduced hours dedicated to each anatomical subject, compared to the old medical curriculum, students may have felt pressed for time with having to learn the information they needed to for their examinations. Why this feeling was prevalent more so in microscopic anatomy than in the other anatomical disciplines remains to be seen, but a proposition is that, because most microscopic anatomy labs are completed on the students' own time, students may wait until the last minute to study that information, leading to them feeling rushed in learning what they need to know for their exams.

These results are not unique to IUSM-B medical students. Medical students throughout all years of schooling and across all countries in the world are stressed out from being required to devote considerable time and energy to lectures, labs, clinicals, and independent study in medical school (Dunn et al., 2008). This issue of medical students feeling rushed cannot be directly attributed to the new medical curriculum. Rather, this may be a long-standing problem in medical education, and it's something that needs to be researched further.

Figure 6.3: Degree to which Medical Students Felt Rushed in Learning Information for Examinations Related to Each Anatomical Subject



n = 26

In total, between 60-80% of students felt rushed to a degree in learning information for their examinations. More students felt rushed in learning microscopic anatomy and neuroanatomy information for their examinations than for gross anatomy.

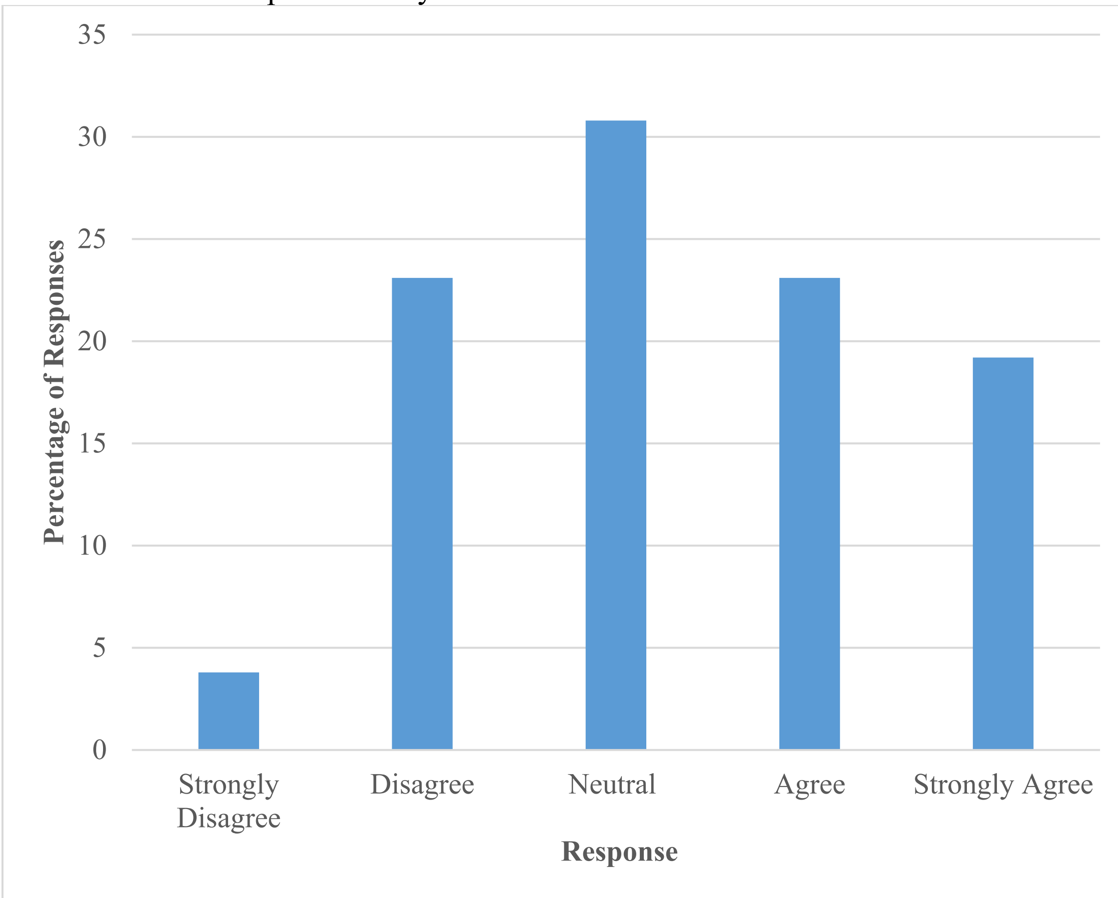
The next question on the survey asked the medical students if they liked the integration of the gross anatomy and microscopic anatomy material in their Human Structure course. The following were possible answer choices for this question:

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

This question received a variety of responses seen in Figure 6.4. Of the 26 students who answered this questions, one student (1; 3.8%) stated they "strongly disagree" with liking the integration; 6 (23.1%) stated they "disagree" with that statement; 8 (30.8%) responded that they felt neutral about it; 6 (23.1%) stated they "agree" about liking the integration; and 5 (19.2%) stated they "strongly agree" with liking the integration of gross and microscopic anatomy.

Overall more students liked the integration of gross anatomy and microscopic anatomy than did not, but this spread of responses shows that students have a variety of feelings towards integration of these disciplines. Previous research has also shown a wide variety of responses toward integration of material. Klement et al. (2017) surveyed medical students whose medical curriculum had undergone revision and found that 81% thought the topics were well correlated. Muller et al. (2008), through interviews with medical students, found that the students liked integration when there was deliberate linkage of different disciplines. However, the students also stated that when faculty did not coordinate with each other about the topics being taught, there could be some redundancies or gaps with the students' learning, leading to more negative perceptions of the curriculum.

Figure 6.4: Medical Student Responses about Liking Integration of Gross and Microscopic Anatomy in Human Structure Course



n = 26

Most students (30.8%) were neutral about the integration of gross and microscopic anatomy, but, overall, the data show that there were a wide variety of perceptions about integration of these two disciplines.

Another survey question asked the students to respond to this statement: "I believe the IUSM curriculum prepared me enough for my NBME subject exam for the below subject topics." The subject topics were the three anatomy disciplines: gross anatomy, microscopic anatomy, and neuroanatomy. The medical students took two NBME subject exams which involved the anatomical sciences: one for their Human Structure course and one for their Neuroscience and Behavior course. The students were told on the survey question to think of the three individual anatomical topics as separate topics. Possible answer choices for this question included the following:

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Figure 6.5 displays the results from this survey item. Only 25 medical students answered this question. One student stopped answering survey questions about the one about liking integration. For gross anatomy information on the NBME, of the 25 students who responded to this question, 3 (12%) stated they “strongly disagree” that the curriculum prepared them enough for gross anatomy-related parts of the NBME; 1 (4%) student responded “disagree;” 6 (24%) felt neutral about it; 12 (48%) responded “agree;” and 3 (12%) responded that they “strongly agree” that the curriculum prepared them well enough for their NBME exams related to gross anatomy information.

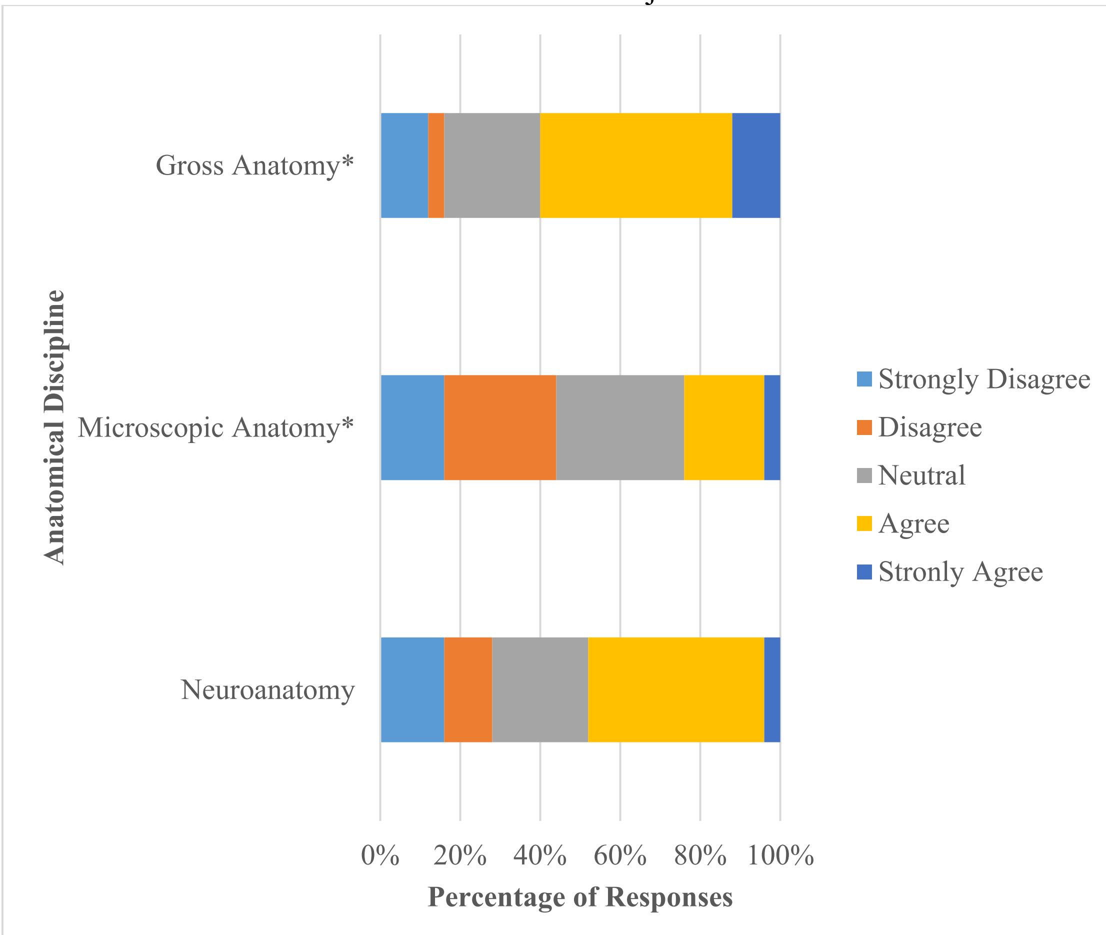
For microscopic anatomy, of the 25 respondents, 4 (16%) stated they “strongly disagree” with the statement of the curriculum preparing them for the microscopic anatomy information on the NBME; 7 (28%) responded “disagree,” 8 (32%) felt neutral about that statement; 5 (20%) responded that they “agree”; and 1 (4%) responded that they strongly agreed that the curriculum prepared them enough for the microscopic anatomy information on their NBME exams.

For neuroanatomy, of the 25 respondents, 4 (16%) stated they “strongly disagree” about the curriculum preparing them enough for the NBME examination; 3 (12%) responded “disagree;” 6 (24%) felt neutral about the statement; 11 (44%) responded that they “agree;” and 1 (4%) responded that they “strongly agree” that the IUSM curriculum prepared them well enough for the NBME exam involving neuroscience information.

Overall, about 60% of students stated they strongly agreed or agreed with IUSM preparing them well enough for their NBME exam involving gross anatomy information, but they felt less confident about the IUSM curriculum preparing them for the microscopic anatomy and neuroanatomy NBME questions. Only 24% of students felt prepared for the microscopic anatomy information on the NBME exam, and only 48% felt prepared for the neuroanatomy information. These findings align with other survey question data from microscopic anatomy and neuroanatomy, where students felt less sure about those subjects than they are about gross anatomy. Moreover, these more negative perceptions could be due to how microscopic anatomy and neuroanatomy drastically changed in the curriculum, compared to the extent that gross anatomy changed. As a reminder from above, in fall 2017, microscopic anatomy had virtually all in-class labs eliminated in the new curriculum – students were to now complete the lab modules on their own time. Additionally, neuroanatomy was reduced from one semester in the legacy curriculum to only six weeks in the new curriculum. And while gross anatomy was reduced from one year to one semester, students still learned most of the same material, just in a slightly compressed fashion.

There is not much research which looks at student perceptions of how the medical curriculum prepared them for their NBME exams, and, for this research, the author did not review student performance on their NBME exams.

Figure 6.5: Degree to which Medical Students Agreed with Feeling Prepared for Anatomical Information in NBME Subject Exams



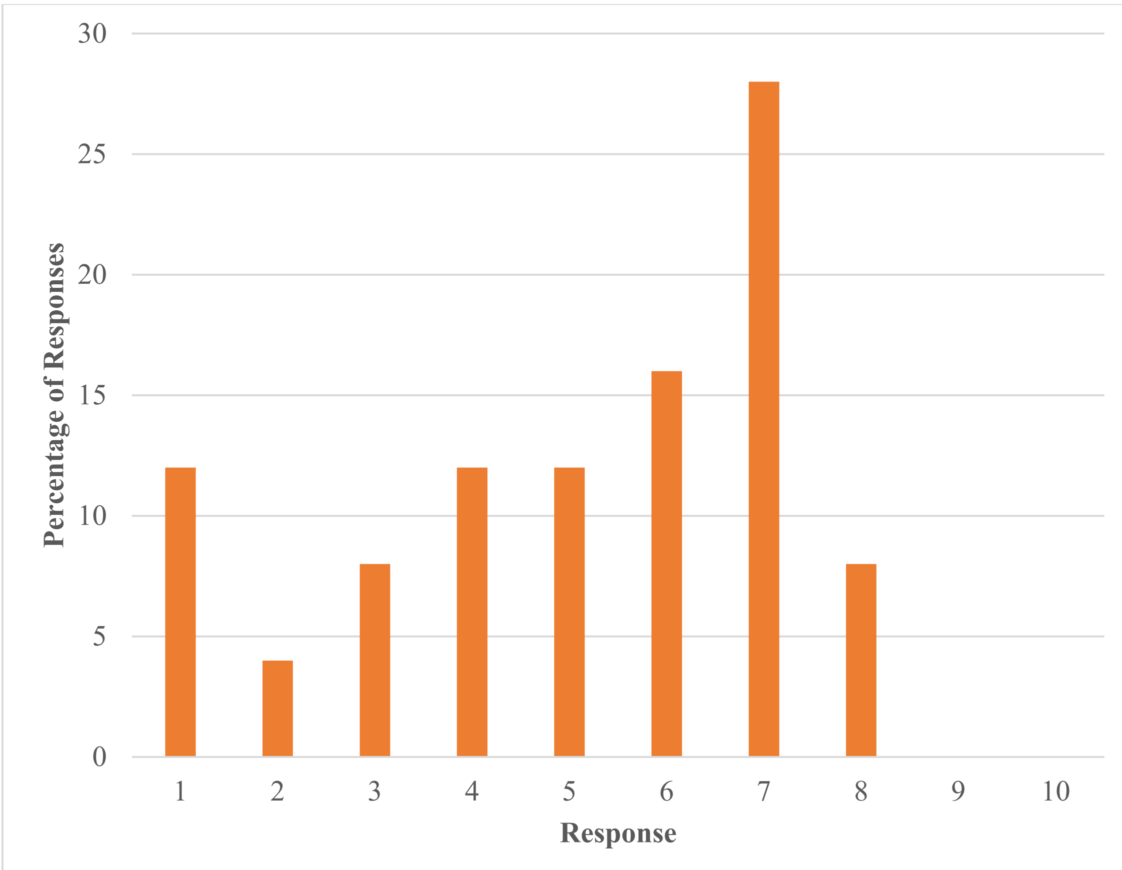
n = 25
*Microscopic anatomy and Gross anatomy were combined in one NBME exam. In the survey question, students were asked to think about the individual questions related to microscopic and gross anatomy
For gross anatomy and neuroanatomy information, most students agreed that the IUSM curriculum was preparing them enough for their NBME subject examinations. Students did not feel as prepared for their NBME exam related to microscopic anatomy information.

The final question of the survey asked the medical students, overall, how satisfied they were with the curriculum at IUSM-B on a 1-10 scale, with 1 being not at all satisfied and 10 being extremely satisfied. These results are displayed in Figure 6.6. Of the 25 students who responded to this question, thirteen (13; 52%) responded with a "6" or higher on the 1-10 scale, while twelve (12; 48%) students responded with a "5" or below

(Mean = 5.08, SD = 2.22). The average satisfaction level from the students at IUSM was lower than the average curricular satisfaction levels from anatomical science faculty at allopathic US medical schools, presented in Chapter 5 (Mean = 6.78, SD = 2.30). First-year medical students at IUSM-B may have been more dissatisfied with their curriculum compared to the general anatomical science faculty population because the IUSM-revised curriculum was still in its infancy. The first cohort of medical students were the first students to experience the revised curriculum. While data from the last chapter did not show any statistically significant associations between length of time since implementation of curriculum reform and perceptions of curriculum, that does not speak to the potential for some association for students. While the sample of students from the second cohort was much smaller than the first cohort, there are some encouraging numbers from those students about their satisfaction of the curriculum. Of the six students from the second cohort who answered the survey, four students (66.7%) answered above a 6 out of 10 (Mean = 5.75, SD = 2.22) for their level of satisfaction with the curriculum. It would be interesting to see in the future if these satisfaction levels of medical students rise in future years, as the new curriculum undergoes further improvements from its initial adoption.

Research on students' satisfaction with a medical curriculum was studied by surveys distributed to second-year medical students by the Association of American Medical Colleges (AAMC). This survey is distributed each year to second-year medical students and asks questions on medical education experiences, the educational environment, career plans and interests, and wellbeing. From 2015-2017, 85% of students stated they agreed or strongly agreed that they were satisfied with the quality of their education (AAMC, 2018). The survey did not track what kind of curriculum the students' medical schools follow, but it does show, that despite what type of curriculum the students experience, they are still overall satisfied with their pre-clinical education.

Figure 6.6: First-year Medical Students' Overall Satisfaction with the Revised Curriculum



n = 25
1 = not at all satisfied, 10 = extremely satisfied

Around 50% of first-year medical students at IUSM-B responded with a 6 or higher on the 1-10 scale about their overall satisfaction of the curriculum (M = 5.08, SD = 2.22).

Qualitative Data Analysis of IUSM-B Student Survey

The qualitative portion of the student surveys consisted of six (6) open-ended questions. These open-ended questions were divided into two (2) specific categories: satisfaction with aspects of anatomical science courses and overall perceptions of the medical curriculum. The first category included questions which said on the survey "Please explain any of your above answer choices to the question." These open-ended questions served to further inform the responses to the quantitative survey questions such as how they felt about the amount of time dedicated to the anatomical science subjects, how rushed they felt with learning the material, how they liked the integration of gross and microscopic anatomy, and how prepared they felt for their NBME final examinations. Similar to the anatomical science faculty members discussed in Chapter 5, the first-year medical students were also asked what they liked most about the curriculum, what they liked least, and what constructive suggestions they had on how to improve the curriculum. As was mentioned in the methodology section of this chapter, content analysis was used as the qualitative methodology on this open-ended data.

Student satisfaction with Anatomical Science Courses in the new IUSM-B curriculum

Table 6.4 displays the codes and sub codes found from the analysis of responses to two open-ended questions: satisfaction with amount of time dedicated to teaching the anatomical sciences and how rushed the students felt with learning the material in the anatomical sciences. The author decided to combine the responses from these two open-ended questions because the student responses were very similar to both questions. Sixteen (16) students responded to the prompt about satisfaction with amount of time, and seven (7) responded to the prompt of how rushed they felt with learning the material. The author assigned 4 codes from the data entitled *Overall Course Organization* (9), *Student Performance* (7), *Rigor* (7), and *Reduced Time* (6).

The quantitative survey results indicated students had issues with how the anatomical science courses (Human Structure and Neuroscience and Behavior) were organized in the curriculum, with comments like "everything is disorganized," and that they felt that both microscopic anatomy and neuroanatomy topics were very "rushed."

As far as student performance in their courses, the reduced time dedicated to teaching the anatomical subjects had an impact on retention of information in the Neuroscience and Behavior course. The following is an exemplar quote demonstrating this code:

> "Neuroscience was insane. No student should have to go through that, and certainly the fact that the average class score on the first exam was below last year's pass cut off of 70% (i.e., the average student would have FAILED the exam under previous standards!!) indicates that it was a grossly suboptimal and poorly managed learning environment, due predominantly to the speed at which the high volume of content was presented."

Aligning with the *student performance* code, many students believed their anatomical science courses to be very rigorously taught due to the reduced hours. One student stated, "Doctors and professors I spoke with about the neuroscience class in particular also expressed that the material was being presented at an unreasonable volume and rate," showing how it's not just the medical students who are noticing the challenges with the revised curriculum.

For the *reduced time* code, students pronounced their dissatisfaction with the "limited amount of true lecture time" for microscopic anatomy concepts. For gross anatomy concepts, a student wanted "more time allotted to go over structures/findings with the professor in the lab."

These data show how students were discontented with the amount of time dedicated to the anatomical sciences at IUSM. Students said that there was an issue with the hours being reduced, material being rushed, and their performance suffering from the last two items. While data has shown in previous research (Cuddy et al., 2013; Hecker and Violato, 2009) and has been discussed in this research how medical students will still do just as well on their high stakes examinations (NBME course exams and USMLE Step exams), irrespective of the type of curriculum a medical school follows, medical students are still stressed with the amount of material they have to learn. This stress may then lead to burnout (Santen et al., 2010). These stressors of a curriculum are the aspects that need to be more closely scrutinized. While stress is nothing new in studying to become a medical doctor, research needs to be conducted on how not to completely overwhelm medical students during medical education in a compressed curricular model.

Table 6.4: Codes for open-ended survey response: Student satisfaction with amount of time in curriculum and extent of feeling rushed to learning information in the curriculum

Codes	Frequency	Select open-ended survey responses
Overall Course Organization	9	For gross anatomy, I wish that there had been more time allotted to go over structures/findings with the professor in the lab. As far as histology, this was a particularly challenging subject for those who had never seen the subject before and I wish we would have had more ways to go over the different slides/images.
Student Performance	7	Neuroscience was insane. No student should have to go through that, and certainly the fact that the average class score on the first exam was below last year's pass cut off of 70% (i.e., the average student would have FAILED the exam under previous standards!!) indicates that it was a grossly suboptimal and poorly managed learning environment, due predominantly to the speed at which the high volume of content was presented.
Rigor	7	Anatomy and histology (neuro included) at IUSM feel very rigorous, and thorough-ness is important to me to feel satisfied with a course Doctors and professors I spoke with about the neuroscience class in particular also expressed that the material was being presented at an unreasonable volume and rate. One physician faculty member told me that he

		himself could not have managed the extreme speed and intensity of this course when he was a med student.
Reduced Time	6	Neuroanatomy is a complex topic and to condense the material into 6 weeks was overwhelming, especially when at least one of the weeks was devoted to just the gross neuroanatomy. I think the 6 week course would have been better suited, to reallocate the gross neuroanatomy to be covered within the normal gross anatomy course so that the full 6 weeks could be devoted to the neurological pathways.

Table 6.5 shows the results from the open-ended question of how satisfied the students felt with the integration of gross anatomy and microscopic anatomy topics in their Human Structure course. There were three (3) codes generated from the data and no sub codes. Eleven (11) medical students responded to this question. *Content Delivery* was the most common code at a frequency of 9, with *Student Performance* having 2 responses, and *Lack of Comparison* having 2 responses.

As far as the delivery of the content, some medical students stated that they liked the integration of gross anatomy and microscopic anatomy in the Human Structure course, and that it was helpful for them to "think about things on different scales." However, others felt like the information was not integrated in a manner that made sense to them, especially for microscopic anatomy: "histology seemed rushed and tacked on at the end of a block and widely varied in efficacy of delivery."

One common trend that was seen in these responses was that students did not have anything to compare this integration to, that they didn't "really have an idea of what it would have been like to have the curriculum as separate classes." Most medical students have not taken gross anatomy or histology before coming to medical school (AAMC, 2019), so they have never experienced these subjects taught any other way. The only comparison a student may make is talking with a friend at another medical school or discussing the curriculum with the medical school cohort ahead of them. One student stated about microscopic anatomy, “In speaking with the class above me, they said they had more practice with it, and did a lot better on histology as a result.” This is in reference to the microscopic anatomy lab portion of the course. Recall from above, in the fall 2016 cohort, those labs were completed in class. However, for the fall 2017 cohort, the majority of the labs were completed out of class.

Table 6.5: Codes for open-ended survey response: Student satisfaction with integration

Codes	Frequency	Select text examples
Content Delivery	9	I like the idea of it, but histology has proven to be very important to future pathology and physiology study and felt underrepresented in human structure. I liked the integration, I just wish more time would have been devoted to lecturing some of the histology rather than all non-didactic.
Student Performance	2	In speaking with the class above me, they said they had more practice with it, and did a lot better on histology as a result
Lack of Comparison	2	I don't really have an idea of what it would have been like to have the curriculum as separate classes.

Table 6.6 displays the results to the question asking the medical students how satisfied they felt with the preparation for their NBME final comprehensive examinations. There were three (3) codes and no sub codes found from the data. *Lack of Preparation* was the most common at a frequency of 4, with *Self-regulated Learning* (2), and *Integration* (1) following. The qualitative responses mirrored the quantitative survey results, where students stated they felt prepared for the gross anatomy part of the NBME, but that they felt ill-prepared for the microscopic anatomy portion of the NBME exam.

In the open-ended questions, the medical students stated that their microscopic anatomy information in Human Structure did not align with the questions on their NBME examination, saying that the NBME exam had “many EM [electron micrograph] identification questions, when our course mainly focused on light microscopy.” Three (3) students also stated that they basically had to teach themselves microscopic anatomy in order to prepare for the NBME exam. One such comment was “I am literally learning everything on my own whenever I am not required to attend class.” One student stated they enjoyed the integration of material in Human Structure and said, “I was successful in the NBME because I studied the basics and extended that knowledge base on my own as I felt was necessary. I feel that histology and gross anatomy are very related and it makes sense to test them simultaneously.”

Table 6.6: Codes for open-ended survey response: Student satisfaction with NBME exams

Codes	Frequency	Select text examples
Lack of Preparation for NBME exams	4	From what I remember for the NBME histology there were many EM identification questions, when our course mainly focused on light microscopy. Need more NBME style practice questions
Self-regulated Learning	2	I am literally learning everything on my own whenever I am not required to attend class. Since we had to teach ourselves the images and what to look for [in histology], we had no way of knowing if what we were learning was correct.
Integration	1	IUSM HS structure gave me the basic material, and I was successful in the NBME because I studied the basics and extended that knowledge base on my own as I felt was necessary. I feel that histology and gross anatomy are very related and it makes sense to test them simultaneously

Medical Student Overall Perceptions of Curriculum

This next section of content analysis of the open-ended questions from the student survey data covers what the students liked about the curriculum, what they disliked, and what constructive suggestions they had to improve the curriculum.

Table 6.7 displays the results about what the medical students liked most about the IUSM-B curriculum. Twenty-two (22) medical students responded to this question. There were two (2) main codes from the data: *Curriculum Organization* (frequency of 19) and *Faculty Support* (2). Under the *Curriculum Organization* code, there were five (5) sub codes: *Grading System* (7), *Systems Integration* (6), *Block Formatting* (3), *Active Learning* (2), and *Standardization* (1). One of the most common responses was that the students really liked the pass/fail grading system, with that specific grading system relieving stress from the students in having to attain a specific grade, or "takes a lot off of the students' shoulders." Slavin and Chibnall (2016) described how their medical school transitioned to a pass/fail grading system in 2012, as part of a larger curricular reform effort. Data from that report found that anxiety and depressive symptoms in first-year medical students greatly decreased in the years since the implementation of that grading system. These authors go on to say how it's not just a transition to a less competitive grading system that helped improve students' wellbeing, but also a focus on providing access to counseling services and other resources for students to utilize. While this issue is beyond the scope of the author's research, she acknowledges that it is a very important topic in medical education.

Other aspects of the curriculum that the students enjoyed was the systems-based approach, specifically for physiology, pathology, and pharmacology. Students also liked "only having 1 class at a time so that you can focus entirely on a subject," as opposed to their first semester when they had both the Human Structure and Molecules to Cells to Tissues (MCT) courses run at the same time. Despite the responses to the previous questions about some students not enjoying the non-didactic learning in the classroom, others did enjoy it, especially the case-based study sessions "when they reinforce topics we've already studied." Finally, one student stated they liked that the IUSM campuses were standardizing and becoming more in sync with each other: "I do like that the curriculum between campuses are meant to be more equal at this point."

For the *Faculty Support* code, the students stated that they enjoyed how the faculty are easy to approach and are "really in favor of the students. They really seem to identify with what we need."

Table 6.7: Codes and sub codes for open-ended survey response: What students like about IUSM-B curriculum

Codes	Sub codes	Frequency	Select text examples
Curriculum Organization		19	See below
	Grading System	7	I like the pass-fail aspect, which takes a lot off of the students' shoulders Pass/fail makes it much less stressful and puts more focus on learning the material vs cramming and not sleeping to get a better grade.
	Systems Integration	6	I like the systems based approach - grouping regional physiology, pathology and pharmacology
	Block Formatting	3	6 week structure allows some downtime during weekends and after an NBME.
	Active Learning	2	I like doing case based problems when they reinforce topics we've already studied.

			Small group learning can be valuable once you have a solid knowledge base, and saves you time studying.
	Standardization	1	I do like that the curriculum between campuses are meant to be more equal at this point
Faculty Support		2	I like how the staff at the Bloomington campus are really in favor of the students. They really seem to identify with what we need.

For the question asking about what the medical students dislike about the curriculum, seen in Table 6.8, there were three (3) codes found: *Curriculum Organization* (24) and *Preparation for Boards* (5). Twenty (20) medical students responded to this question. Under the *Curriculum Organization* code, there were four (4) sub codes: *Overall Organization* (9), *Reduced Time* (8), *Standardization* (1), and *Non-didactic Learning* (6). The students had some issues with how specifically the information in the curriculum fit together; they couldn't see "how things link up." They also did not like how the reduced time in the curriculum made them feel rushed with having to learn all of the information in a short amount of time. One student stated, "I have increasingly felt that a week, or even a few days time at the end of each course - to review and retain information - would have been so incredibly helpful to my learning process." As far as the *Non-didactic Learning* sub code, even though some students liked the case-based study sessions, from the responses above, some students disliked the small group learning environment, saying that it was "a huge waste of time." The students stated that the emphasis on the required small group learning sessions was harmful for their learning, that it "takes away from time to learn about the subjects in the first place." Additionally, they proposed for the instructors to more carefully consider where in the curriculum the small group sessions should be placed. Finally, and in contrast to what one student liked about the curriculum, one student stated they did not like the standardization of the IUSM curriculum, that this attempt “trying to unify all campuses and make them equal is not working.”

The final code was *Preparation for NBME course exams and USMLE Step exams*. These medical students have not taken their Step 1 exam at the time of this focus group; however, early in medical school, many students will have a focus on the Step 1 examination. This exam is the one that is used for residency placement, so students strive to do as well as they can on it. However, because, often, medical programs have shifted to a pass/fail curriculum, the USMLE Step 1 exam is one of the only determining factors for residency placement. Recently, there has been a call to change the Step 1 exam to only report pass/fail (Chen et al., 2019). The authors of that report are medical students who have seen the stress of Step 1, including issues with wellbeing. They also raise the question of what is the point of undergraduate medical education (UME) if the focus is only going to be on Step 1 scores? This issue was discussed to a degree in Chapter 5 in the results of the faculty interviews. Medical students, especially the ones surveyed for this research, stated they want to have a focus on preparation for their NBME course exams and USMLE Step exams, saying that the lack of it in the IUSM curriculum is “impeding our ability to succeed on board exams which is truly what determines our future.” This sentiment is discussed again under the qualitative analysis of medical student focus groups.

Table 6.8: Codes and sub codes for open-ended survey response: What students dislike about IUSM-B curriculum

Codes	Sub codes	Frequency	Select text examples
Curriculum Organization		24	See below
	Overall Organization	9	Some information doesn't seem put together well. In the initial courses it's difficult to see how things link up… It is not put together well, it squishes things together and does not allow enough time for actual learning.
	Reduced Time	8	I do not like how quickly we are going through systems. I have increasingly felt that a week, or even a few days time at the end of each course - to review and retain information - would have been so incredibly helpful to my learning process.
	Non-didactic Learning	6	I think the formalization of didactic/nondidatic sessions is restricting. It would be better if individual instructors could determine how they believe that material ought to be taught. Emphasis on small group time takes away from time to learn about the subjects in the first place and many students have to use outside resources to learn the material. Also, some small groups after an exam are related to topics from the previous blocks but not the current one.
	Standardization	1	students and instructors feel rushed, trying to unify all campuses and make them equal is not working
Preparation for NBME course exams and USMLE Step exams		5	The curriculum really is not in our best interest. It is impeding our ability to succeed on board exams which is truly what determines our future.

As far as constructive suggestions on how to improve the curriculum, the students had many suggestions. These results are displayed in Table 6.9. The main codes found from the data include *Curriculum Organization* (18), *Preparation for NBME course exams and USMLE Step exams* (5), *Communication* (4), and *Interprofessional Skills* (2).

Curriculum Organization had sub codes of *Increase Time* (6), *Reevaluate how material is presented* (5), *Efficient Active Learning* (4), and *De-standardize Curriculum* (2). Aligning with the student displeasure of the reduced time in the curriculum, some students called for increased time to teach the material, such as "make anatomy a yearlong course," like how it was organized in the legacy curriculum. Additionally, the medical students did not like only having two weeks for neuroanatomy, saying that it was "extremely aggressive, much of the most important information was thrown at us." Students also wanted a closer look at how material is presented in the curriculum. One student did not like how "histology was split between MCT and Human structures," saying it "made it seem choppy and incomplete."

As far as active learning in the classroom, students saw the benefit of it, but they wanted it to be taught more efficiently, such as using "TBL time to go through practice cases as a class...Have it more professor-led so we actually learn the material vs. guessing/googling/sitting there talking and wasting time until the professor gives us the answer." Active learning may be difficult to implement initially, especially for educators who have primarily lectured in the academic careers. In a study by Andrews et al. (2011), college science lecturers who taught an introductory biology course at twenty-eight different institutions in the United States were surveyed about their teaching methods. Additionally, their students were tested using a pre and post test. In that report, students in classes where their instructor was using active learning were not any more likely to be successful on the post test, compared to students whose instructor did not use active learning. The authors stated that it was not necessarily active learning itself that was causing the lack of knowledge gain, but how the instructors were using it in the classroom. Often, instructors are not trained in educational theory and pedagogy, and that may contribute to the negative perceptions of students about certain active learning strategies in certain courses, that was evidenced from the first-year medical student surveys.

Finally, two students wanted to see a reversal back to the original medical curriculum at IUSM, and that they want instructors to "teach how they want to and write their own tests for their campus."

Another common suggestion was for the curriculum to focus on preparing the students for the NBME course exams and USMLE Step examinations, such as "integrating high yield/board material instead of material that we all know will not be remembered or useful" on their unit exams. Again, very similar to the data from Table 6.8, one of the primary focus of the students is how well they do on that Step 1 examination. One student stated in a pleading manner, "We NEED to do well, and it is not fair that we suffer the consequences of a first-draft on a new curriculum. My future is on the line." This is evidence with how much pressure the medical students are supposedly under to do well enough on their Step 1 exam, especially since the curriculum has shifted to be pass/fail.

The students also desired for an increased emphasis of interprofessional education: "give us more challenging problems to work on that will demonstrate communication skills. Learning formalized communication method is difficult to take seriously to be honest."

Finally, the students wanted more "clear and transparent communication from administration to students in updates throughout the curriculum" and especially more communication between "the Medical Student Council and the Curriculum Steering Committee." The Medical Student Council is a medical student leadership group which helps govern the IUSM student body, while the Curriculum Steering Committee sets curricular policy for IUSM (IUSM, 2019).

Table 6.9: Codes and sub codes for open-ended survey response: Suggestions for improving IUSM-B curriculum

Codes	Sub codes	Frequency	Select text examples
Curriculum Organization		18	See below
	Increase Time	6	Not have step1 be so early, even an extra 2 weeks would be nice, some schools take their step1 in june. The rushed schedule makes student feel more stressed and rushed. Neuroanatomy in the first two weeks was extremely aggressive, much of the most important information was thrown at us
	Reevaluate how material is presented	5	Reevaluation of the order of material presented - how histology was split between MCT and Human structures made it seem choppy and incomplete Give more time for Neuroscience. Consider separating it from Psychiatry. Also, make anatomy a yearlong course
	Efficient Active Learning	4	Use TBL time to go through practice cases as a class (at the campuses) and maybe in larger groups with a professor/preceptor in Indy. Have it

			more professor led so we actually learn the material vs. guessing/googling/sitting there talking and wasting time until the professor gives us the answer
	De-standardize curriculum	2	Give us back the old curriculum. IUSM is unique because we have 9 different campuses with 9 different sets of faculty and 9 different ways of doing things. You've ruined that. let instructors teach how they want to and write their own tests for their campus
Preparation for NBME course exams and USMLE Step exams		5	…I think integrating high yield/board material instead of material that we all know will not be remembered or useful. We NEED to do well, and it is not fair that we suffer the consequences of a first-draft on a new curriculum. My future is on the line.
Communication		4	Clear and transparent communication from administration to students in updates throughout the curriculum would be appreciated. An understanding of the student perspective and student wellness from the administration could be improved. I would like to see more interaction between the Medical Student Council and the Curriculum Steering Committee
Interprofessional Skills		2	For interprofessional skills, give us more challenging problems to work on that will demonstrate communication skills. Learning formalized communication method is difficult to take seriously to be honest.

From these open-ended survey responses by first-year medical students at IUSM-B, it was found that students had issues with how some of the content was organized in the medical curriculum. The students stated how some aspects of the curriculum were disorganized. Students also felt very rushed with having the learn material for their exams in a short amount of time, especially for the 6-week course of Neuroscience and Behavior. One of the more striking and somewhat troubling sentiments from these survey responses was that stress seemed to take a prominent feature in the students' lives already. At the point that the survey was administered, the medial students still had many months before their Step 1 exam, but many were already stressing over how they would do on the exam. This same type of stress has been found multiple times in studies on medical student wellbeing and mental health (Chen et al., 2019; Slavin and Chibnall, 2016; Van der Heijden et al., 2008). This same belief is discussed in the next section of medical student focus group data.

Qualitative Data Analysis of Student Focus Group

Nineteen (19) first-year medical students from the fall 2016 cohort at IUSM-B consented to this part of the research by coming to the focus group session and signing an informed consent sheet. This focus group served as a chance for the students to expand upon their answers to the survey questions. Many of the same questions asked as quantitative questions in the survey were asked in the interview (see Appendix E for a list of the interview questions). The specific methods used to conduct this part of the research are located in both Chapter 4 and in the beginning of this chapter.

The codes, categories, and themes discovered from the thematic analysis of the student focus group are described below. There are two tables (Tables 6.10 and 6.11) which each present one particular theme found from the data, and all its corresponding categories and codes, along with exemplar quotations from the participants, credited via numerical identifiers in parentheses at the end of the quotation. Included with each of the tables, the author discusses in further detail the meaning behind each code and how those codes formed both the categories and the overall themes.

Theme 1: The medical school (IUSM) needs to be more transparent with its students

Table 6.10 displays the codes and categories that formed the theme "The medical school needs to be more transparent with its students." We know, from the data seen in Chapter 5 of this report, that the administration typically is the primary driver of curricular reform. Additionally, from the faculty interviews and survey results, many faculty members wanted to see more communication with the administration. This holds true for the first-year medical students from IUSM-B as well. These students wanted the administration to be more forthcoming with the schedule of the curriculum, "there was no finalized schedule yet until about a week before classes began," and "It's very much they are planning out the courses as they are happening, and I don't know why they haven't been planned out the year before." Another comment of concern from the students was "None of us know what's going to happen for third year."

As far as the purported standardization of the IUSM curriculum, students noticed a disconnect between what they were told was going to happen and what actually happened with the standardization of the nine campuses of IUSM, especially in regard to the information on their course examinations. Since examinations are written by all the faculty from each of the nine campuses who teach that course, there is no way of knowing what will be on the examination until the students took their examinations. One comment was that the learning objectives for the courses did not line up with what was on the examination, causing confusion among the students on what they needed to know for their unit exams. One student gave an example of this miscommunication: “we were told we didn’t need to know origins and insertions, but a few of those showed up on the exam. But the person who is writing exam is not the person teaching, which I think is the biggest problem with the exams.”

The fact that not all questions asked on the unit exams were written by the person teaching the students was a major factor in student dissatisfaction with the curriculum. Other reactions from the students were ones of frustration and confusion. Students were told that they would not be guinea pigs with this curricular reform, but, in reality, they felt they were: “I would like it on record to that the 9 or 10 times they said we are not going to be guinea pigs, that they were lying to us.”

Despite the more negative feelings of frustration and confusion with this curriculum, some students were optimistic about it. A few stated that they believed the curriculum would be successful, but that there were kinks that needed to be worked out. Another student compared the process of managing and new curricular format to “dealing with the frustration of hospitals and administration.”

Table 6.10: Student Focus Group Theme 1: The medical school (IUSM) needs to be more transparent with its students

Categories	**Codes**	**Select Text**
Standardization	Disconnectedness	Even with the human structure, there was somewhat of a disconnect between what we were told to know and what showed up on the exam. Like, for example, we were told we didn't need to know origins and insertions, but a few of those showed up on the exam. But the person who is writing exam is not the person teaching, which I think is the biggest problem with the exams (02) And that makes it difficult to teach and highlight what we need to know and what we don't need to know. Because the teachers don't have any idea what the exam is going to look like a week before, sometimes less than a week before. (11)
	Communication	I think it [integration] worked pretty well with Drs. XX and XX because they worked really well together and organized that well, but, I think, a lot of the rest of the courses they did that in, there wasn't communication with others, so they would talk about something and not explain it, so it was, like, they were trying to get the best people on the topic to teach it, but sometimes it wasn't communicated well across the board what we have been taught and what we had not. (11)
Reactions	Frustration	I would like it on record to that the 9 or 10 times they said we are not going to be guinea pigs, that they were lying to us. … I know most of the curriculum is administration stuff, but the professors do a good job of telling us if we have any questions or want further explanation of the material, we can just come to them. They appreciate our frustration and also are frustrated themselves. The professors here are really great (11)
	Confusion	It's very much they are planning out the courses as they are happening, and I don't know why they haven't been planned out the year before. (17)
	Optimism	I actually feel like this is gonna work, that we just need to get all the bugs out of it. It just kinda sucks right now. (02)

Theme 2: IUSM-B students want to be taught to the NBME course exam and Step examinations, in addition to having early clinical experiences.

Table 6.11 displays the codes and categories that formed the theme "IUSM-B students want to be taught to the NBME course exam and Step examinations, in addition to having early clinical experiences." Findings supporting this theme were similar to the findings from the content analysis of the open-ended survey questions from the student survey results, where succeeding on the NBME course exams and USMLE Step examinations were the most important parts of medical school for students. Many students were surprised at how easy they found the NBME exams to be, compared to their unit exams: "I always though the NBME question-wise was way more straight-forward." Students want to be taught to a standardized test. However, this is not a very pedagogically-sound practice. As has been studied extensively with the use of standardized tests in all areas of education (Volante, 2004), there are both positives and negatives of the use of these types of tests. A standardized test is just that – standardized. It allows for the comparison of results either across various campuses (as with the NBME course exams and IUSM) or across the nation (as with the USMLE Step examinations). However, as has been studied in medical education, it's often those students who are generally good test takers that do better on the NBME course exams and USMLE Step exams (Donnon et al., 2007; Gauer et al., 2016; Haught and Walls, 2004). Additionally, it's often those students who can afford to spend money on resources (e.g., testing booklets) that do better as well (Chen et al., 2019). Preparing for and worrying about standardized tests, as mentioned above, may also contribute to anxiety and depression issues in students, as those tests are generally seen as high stakes (Chen et al., 2019; Segool et al., 2013).

As far as teaching to the test, it has been found to reduce the depth of instruction in the course (Volante, 2004). This has been very evident by the medical students from IUSM-B who wanted more NBME and USMLE Step-style exam questions on their unit examinations: “maybe make all our exams NBME style, because we are studying all the material for boards anyways.” As is explained in the next chapter (Chapter 7) for the conclusions and recommendations from this research, looking at performance on these standardized tests should not be the only measure of success of a medical curriculum.

Active learning components are a vital component of a medical curriculum and help increase long-term retention of material, past the NBME and USMLE Step exams and into a physician’s career (Emke et al., 2016; Gottlieb et al., 2017; Jurjus et al., 2014). These active learning strategies need to be incorporated into a medical curriculum in a meaningful way in order for this process of long-term retention of material to work. This statement was not necessarily true to the IUSM-B medical students; many stated that the active learning at IUSM-B was organized in a very inefficient manner. This statement was particularly true for the team-based learning (TBL) sessions. Students said that some faculty and clinicians didn’t really know what to do in a TBL session – that it just seemed like “a waste of time.” Another student stated that they “would rather not have anything in TBL format. I would rather just go to lectures.” Again, this may be due to faculty not being trained in how to run an active learning session well, as was found with the study by Andrews et al. (2011). Please see Chapter 7 for explanations on how to deliberately incorporate active learning sessions into the medical curriculum.

Probably seen as the best part of the new curriculum, students stated that they really enjoyed having "clinical exposure really early on." This is a very important aspect of a medical curriculum, that students are able to utilize their basic science information within the clinic in order to reinforce their learning. Another student stated, "I really like when we get patients. I remember one patient that was paralyzed. It really helped grasped what we were learning." Clinical experience is vital for medical students to receive early in their training (Cooke et al., 2010). In research by Das et al. (2017), they divided medical students into two groups, where one group had clinical exposure with patients with respiratory issues, and the other group only learned respiratory physiology through general classroom teaching. After testing the two groups on respiratory physiology concepts, it was found that the group that had the clinical exposure performed significantly better. Not only should students have the ability to interact with patients, but there should be clear and deliberate integration of basic and clinical information at all levels of the medical curriculum. This concept is further discussed in Chapter 7.

Table 6.11: Student Focus Group Theme 2: IUSM-B students want to be taught to the NBME course exam and Step examinations, in addition to having early clinical experiences

Categories	Codes	Select Text
Organization of the curriculum	Team-based learning	I think part of it is that if the TBLs were used to practice material we learned, that would be effective. But if it's just for material that we haven't learned ourselves yet, it is not useful. I would appreciate them if they were used to review and go over material. I think they were used pretty well in the host and defense course. TBLs and PBLs that were integrating material that we already learned, then they were really good, but in MCT, I don't know what these proteins are. It's expected that you learn from the TBL, that's not really working for anyone. (17) I think it should enhance what you have done in lecture and not replace it. I think at times we would be held accountable for an entire lecture that was not lecture like. (08)
	Integration	Yeah, I really liked the integration in theory than in practice. A lot of times it seemed disjointed. I could see that they were doing some sort of integration, but the connections weren't being made. So, it seems like they were having random classes on different topics. This was similar when we had a biochem lecture and they threw in a random genetics lecture, and it was tangentially relevant but not so much. The connections need to be show more, I think. (17)
Outcomes	NBME examinations	I always though the NBME question-wise was way more straight-forward. (S02) I was a little surprised on how the NBME were way easier compared to class exams.(17)

	Clinical Experience	We get clinical exposure really early on. I don't think it's that common. We can talk about boards and whatnot, but the clinical exposure early on is great. (09)

First-year medical student perceptions of the IUSM curriculum were ones of frustration, confusion, and even optimism. There were both positive and negative aspects of the curricular change at IUSM. Some of the negative aspects included the lack of transparency about what would be taught in the curriculum and the reduced hours dedicated to the anatomical sciences (especially neuroanatomy). This reduction of hours due to curricular reform has been seen time and time again as an impact on the anatomical sciences (McBride and Drake, 2018). Some positive aspects of the IUSM curricular change included the transition to the pass/fail curriculum, a focus on the integration of material, and early clinical experiences. The last two aspects were ones recommended by Cooke et al. (2010) to best educate future physicians. Part of some of these perceptions of the medical students may be attributed to what Miles et al. (2012) reported: that the educational environment in which students are enrolled influences their satisfaction with the curriculum and their academic success in that curriculum. This new curriculum at IUSM was quite an endeavor. The curriculum went from individual campuses teaching in their own manner, to a standardized campus system. This new educational environment for IUSM-B may have contributed to some of the more negative feelings about the curriculum. As mentioned before, only collecting focus group data on one cohort is a limitation of this research. It would have been a good idea to see if perceptions had changed from one cohort to the next.

Qualitative Analysis of IUSM-B Anatomical Science Faculty Focus Group

Three (3) anatomical science faculty members from IUSM-B and one (1) graduate student in the Education track in Anatomy PhD program (who served as an associate instructor [graduate teaching assistant] for medical-level courses in the anatomical sciences) were participants in the faculty focus group. Of the four (4) faculty instructors who teach the medical-level anatomical science courses at IUSM-B, the author talked with the two gross anatomy and one microscopic anatomy faculty for the focus group (and the one associate instructor). The neuroanatomy faculty member was out of town on the day the focus group took place.

This focus group allowed the faculty to talk about their involvement with the IUSM curricular reform and discuss how specifically the anatomical science courses changed due to curricular reform. Appendix F has a list of the interview questions. The specific methods used to conduct this part of the research are located in both Chapter 4 and in the beginning of this chapter.

The codes, categories, and themes discovered from the thematic analysis of the student focus group are described below. There are two tables (Tables 6.12 and 6.13), each of which present one of two themes found from the data, and the theme's corresponding categories and codes. Each code has an exemplar quotation from the participants, credited via numerical identifiers in parentheses at the end of the quotation.

Theme 1: There is a desire for a one-size-fits-all approach for the IUSM curriculum, but the implementation of the new curriculum proves to be difficult

Table 6.12 displays the codes and categories that formed the theme "There is a desire for a one-size-fits-all approach for the IUSM curriculum, but the implementation of the new curriculum proves to be difficult." Data from Chapters 4 and 5 have shown that there is *not* a standard type of curriculum that all medical schools follow. However, as stated above, one of the goals of curricular reform at IUSM was to demonstrate consistency of learning experiences across campuses, from the smallest campus at IUSM-

Muncie at 56 total students, to the largest campus in at IUSM-Indianapolis with 833 total students (IUSM, 2017-2018). The way to ensure this consistency was to implement the same type of curriculum across all of the campuses.

While it is important for the administration to unite all campuses as one, larger medical school for the consistency of learning, as guided by the LCME Standards, the implementation of this change proved to be a challenge for all involved. The faculty from this focus group stated that it was laborious to teach the same type of curriculum at each campus, especially when "you're at a small center with 14 students and a larger center with 150." Additional difficulties teaching a standardized curriculum included variations in lab space and resources, "like ultrasound…where were trying to find ways to incorporate ultrasound because we have machines and we know it's a benefit to our students, but it's severely limited because not every campus has that as a resource."

While many of the statements for this theme were negative, there were some positive outcomes from this standardization. There is currently more interaction among faculty from different IUSM campuses: "there is much more discussion and collaboration among the different groups, so we are able to interact with fellow faculty across the state and share some ideas." This collaboration was also seen as a positive aspect from faculty interviews in a study published by Muller et al. (2008). And while that study only looked at one campus (as opposed to IUSM's 9 campuses), it is heartening to know that faculty enjoy working with other from different departments and from different campuses.

One of the primary outcomes from this focus group, in addition to the data from the general anatomical science faculty from around the United States presented in Chapter 5, is that curricular change is constant. There will always be change occurring with the curriculum, from a minor tweak to a complete overhaul of the curriculum: “you have to reinvent the curriculum every single year for the first five years…I suspect that fall 2018 will see a lot of new changes again.” This trend was also seen in faculty interviews discussed in Chapter 5, where some faculty talked about the ongoing process of curricular reform, as “cyclical.”

In an article by Sparapani and Perez (2015), they offered their perspectives on the standardization of curricula, and its effects on teaching and learning. And while not specific to medical education, there were some important similarities with the data about standardization at IUSM. First, standardization is primarily driven by policy, and this was seen to be true for IUSM, to align with the LCME standards. Second, there’s a need to evaluate if standardization is appropriate for everyone. This statement is very true for IUSM as well because the campuses have various numbers of student enrollment. Third, there’s a need to review how teaching practices can both meet the needs of the learners and those of the policy makers. The authors primarily discussed their perspectives on how stakeholders can best implement standardization, and the primary means is to actively involve all those who are interested in curricular design and allow them to have a voice. This concept is further discussed in Chapter 7.

Table 6.12: Faculty Focus Group Theme 1: There is a desire for a one-size-fits-all approach for the IUSM curriculum, but the implementation of the new curriculum proves to be difficult

Categories	Codes	Select Text
Reasons for Curricular Reform	LCME	I think the easy answer is the LCME. But, um, let’s be honest. The curriculum was not changed since the 1970s. And, uh, times have changed. There had to be something done. (01)
	Standardize Campuses	…we had 9 centers as a result of the LCME as a part inspired by the LCME upcoming review all of the centers needed to demonstrate comparable learning activities which initially felt very much like exactly identical activities. Very difficult to do if you're at a small center with 14 students and a larger center with 150. (02)
Reactions	Constant Change	Seems like you have to reinvent the curriculum every single year for the first five years I would say that she's correct so as you know we have the same course is the same: integrate and revise. We have the same template. The number of changes we been making to all of these courses has been dramatic. I feel that there are a lot of changes in this course that are significant compared to last year, and I suspect that fall 2018 will see a lot of new changes again. Ultimately, they are for the benefit it wasn't one and done thing. (02)
	Faculty Collaboration	And you got people that have done things differently and successfully from numerous years so why should I change it, but it doesn't work at other places. But I also think that interaction is positive. We know, at least for me, I actually know the anatomists at all campuses, right, and so I think that can be a benefit both in terms of how are you doing how are you doing for that communication as well as I could see it being beneficial if you're going up for promotion and tenure. They know who you are, right, there is at least people on every campus that knows us which can be beneficial. (03)

Theme 2: The shift to a standardized curriculum has both positive and negative aspects for the teaching and learning of the anatomical sciences

Table 6.13 displays the codes and categories that formed the theme "The shift to a standardized curriculum has both positive and negative aspects for the teaching and learning of the anatomical sciences." Some of these positive aspects included the ability for students to make clearer connections by having "more intention to that integration" of gross and microscopic anatomy of "entire organs from the cell on up."

An additional positive aspect of the curriculum was the improvement of professionalism from the students, including communication and presentation skills from doing peer teaching in the gross anatomy lab. This peer teaching was an aspect of the curriculum that was initially removed in fall 2016 but then "we fought for it and now it's going to be incorporated all the other centers from this point forward," showing how the administration was receptive to feedback from faculty.

Some of the more negative aspects highlighted by members of the focus group included reduced time in the curriculum, especially dedicated to the anatomical science courses. The IUSM-B faculty were concerned that there were critical pieces of knowledge that students were missing in this first year, and that they were "not entirely convinced students will gain additional understanding in later courses." As one faculty member noted, "I'm worried if there is something fundamental that students may never get in their medical career." These statements reinforce the data from the faculty surveys in Chapter 5, where many faculty whose medical school had undergone recent curricular reform were more likely to believe their students were not receiving adequate knowledge in the anatomical sciences. Whether this belief actually has an impact on student success as a physician remains to be seen, as there is very little data following student success after they have completed their medical education. Additionally, it also ties into the question posed to the US medical school faculty during their interviews about how they would define and measure the success of their medical students. Success of medical students is an important concept that needs further study.

Another negative aspect discussed by the IUSM-B faculty included the shift to an excessive focus on the pass/fail grading system, which was a difference between what the IUSM-B students stated and what the IUSM-B faculty stated. While students were pleased by the shift to a pass/fail system, faculty were skeptical of it. One faculty member mentioned how the new grading system was their "biggest concern with this curriculum." They stated, "we've had passing rates that were so low that I just don't have a lot of confidence in that." An example was given where a student may receive a 58% on an examination, and that would be considered passing; whereas, with the legacy curriculum, any student receiving below a 70% would fail that examination.

Another difference between what the first-year medical students and the anatomical science faculty at IUSM-B stated in their respective focus groups was about the self-regulated learning features of the curriculum, especially related to microscopic anatomy information. The medical students stated that those sessions were too independent, meaning they were not given directions on how to properly learn the material. However, the microscopic anatomy faculty member stated how well microscopic anatomy (especially the lab portion) lent itself to being learned independently, that it was "designed for self-study, and there is not a reason where you have to come in to class." He went on to say, "Histology at the lab level can be learned independently and much better, I believe, instead of being in a class. And so, because it's a time constraint we have, the elimination of that is good."

Table 6.13: Faculty Focus Group Theme 2: The shift to a standardized curriculum has both positive and negative aspects for the teaching and learning of the anatomical sciences

Categories	Codes	Select Text
Integration of material	Clearer Connections	There is more intention for the integration in years past. when histology and Gross were separate courses, there were several subjects that we teach about the same time and we make comments to the student, and we say ‘well let’s look at the gross anatomy of the heart this morning. Let’s examine histology of the heart’, but now there is more intention to that integration, and we had many more places for students to examine both the whole organ and the histological aspect. So I think they're getting a better understanding of entire organs from the cell on up. (02)
	Reduced Time	…as a result of this curricular reform, all of us have had content and time cut from the courses, and some of that time cut we’ve been okay with. But there’s been other places where I feel we do have an actual deficit that we are not entirely convinced students will gain additional understanding in later courses (02)
Student Outcomes	Grading System	And that's actually my biggest concern with this curriculum is the low pass because we've had passing rates that were so low that I just don't have a lot of confidence in that. Yeah, its two standard deviations. (03)
	Deficit in Learning	But there’s been other places where I feel we do have an actual deficit that we are not entirely convinced students will gain additional understanding in later courses. We would feel better if I knew that students were going to approach a particular topic in slightly more advanced aspect later on in the medical career, and I’m not yet convinced of that. So when we have to cut certain aspects because we know we have only X amount hours or X amount of minutes in a particular lecture to discuss something, I'm worried if there is

		something fundamental that students may never get in their medical career. (02)
	Professionalism	And that [peer teaching] will hopefully improve communication skills and presentation skills and there's a lot of benefits to that. (F03)

Final Thoughts Regarding Research and Analysis of Case Study Data from Indiana University School of Medicine-Bloomington

One of the major reasons that Indiana University School of Medicine underwent curricular reform was due to the LCME desiring the nine campuses to be more standardized. Meeting LCME standards was also a common reason for medical schools to have undergone curricular reform for many other medical schools (Heiman et al., 2018; Klement et al., 2017). Prior to curricular reform, the nine IUSM campuses varied with respect to length of their courses, types of course exams, and instructional format. After the new curriculum was implemented in fall 2016, all nine campuses taught to the same set of session, course, and institutional learning objectives, used standardized examinations, and had the same exact scheduling of courses. Additionally, the university integrated many courses together in the first year of the medical program and organized the second-year courses into systems-based blocks. There was also a focus on more active learning and small group activities in the classroom, with lectures making up no more than 50% of the curriculum. Many other medical schools have also organized their curricula in similar manners (Brooks et al., 2015; Ginzburg et al.,2015; Heiman et al., 2018; Klement et al., 2017).

While it was important to understand the “why” and the “how” of the curricular reform at IUSM, it was also imperative to know what the impacts were of this reform, and that was accomplished by discussing the curricular reform with faculty and students who have first-hand experience with it.

The goal of this part of the project was to answer the following research questions:

Research Question 4: What are medical student and faculty perceptions of curricular reform at a case study institution (Indiana University School of Medicine-Bloomington), and how do they compare to the US landscape?

a. How do first-year medical students IUSM-B perceive the newly implemented medical curriculum that began in Fall of 2016?

b. How do anatomy faculty perceptions of curricular reform at IUSM-B compare to anatomy faculty perceptions from other US medical schools?

The data collected and analyzed via surveys and interviews of the students and anatomical science faculty members at IUSM-B provided valuable information on the impact the curricular reform has had on their perceptions of the curriculum. The analysis of the student surveys showed that the students were not very satisfied with how microscopic anatomy and neuroanatomy were organized into the medical curriculum, specifically how much time they had devoted to learning those subjects. With the Neurobiology and Behavior course being only six weeks in length, that did not leave much time to fully learn the information prior to their course examinations. This reduction in time to learn material was also a common trend seen from the US medical school faculty survey responses from Chapter 5, and also reinforced from survey data collected by McBride and Drake (2018). However, many students also said that they felt prepared for their NBME final comprehensive examinations, showing how, even in a revised curriculum, students are going to perform well on their high stakes examinations (Cuddy et al., 2013; Klement et al., 2017).

One of the primary comments that was seen in both the open-ended survey responses and focus group from the students was the lack of communication from the faculty and administration. This administration oversight was also a common trend found in faculty interviews from Chapter 5. Students from IUSM-B did not like how even the faculty did not know what would be on the examinations. The students also did not like how they were not given directions for the self-directed learning and out-of-class activities, such as the histology lab modules they had to complete on their own time.

Some positive aspects of the curricular reform, that the students agreed upon, were the early clinical exposures they received by being able to see patients very early on in their medical career. Students were very appreciative of that opportunity, while realizing that not all medical schools allow their students to see patients early on. There is not explicit data on the numbers of medical schools that allow their students to see patients early in the pre-clerkship years. In Chapter 4, with the analysis of medical curricula, per website descriptions, a number of medical schools stated they had early clinical experience, and that was coded into "integration of basic and clinical sciences;" however, there was no real indication on specifically what medical programs provided to their students, as far those early clinical experiences. There are a number of LCME Standards which involve clinical experiences. The following passage is an example (LCME, 2018, Standard 3.1):

> "Each medical student in a medical education program participates in one or more required clinical experiences conducted in a health care setting in which he or she works with resident physicians currently enrolled in an accredited program of graduate medical education" (pg. 4).

This Standard only states that a clinical experience is a requirement, but it does not state *when* medical students should undertake this clinical experience.

From the focus groups of the IUSM-B anatomical science faculty, there were both positive and negative reactions to the curricular reform. One major feature of the curriculum, the grading system, was met with gratitude from the students but skepticism from the faculty. Faculty did not believe a pass/fail grading system was conducive for learning the material, if a student just needs to perform at two standard deviations below the mean in order to pass. However, students saw that as a positive, allowing for the reduction in competition among peers that supposedly occurred with the old grading system at IUSM, which is a concept also reinforced from Chen et al. (2019). IUSM-B faculty stated how they were appreciative of the faculty collaborations among instructors from the other campuses, those whom they might not know or talk with otherwise. This sentiment was also reinforced by data from US medical school faculty surveys and interviews in Chapter 5 and from data from Muller et al. (2008).

While much of this research from IUSM-B first-year medical students and anatomical science faculty talked about the standardization aspect of the IUSM curriculum, something which is very unique to IUSM, many of the same trends were found with faculty members from other medical institutions. These similar trends show how the curricular reform has impacted the teaching and learning of the anatomical sciences at medical schools throughout the United States.

Chapter 4 of this research analyzed the websites of medical schools in the United States and generated a new schema on how to classify medical curriculum. Chapter 5 examined how many medical schools had undergone curricular reform in the last ten years, how specifically the anatomical science courses had changed due to that curricular reform, and what faculty perceptions were of the reform. This Chapter presented information on how one medical school, Indiana University School of Medicine, revised its medical curriculum and the impact that revision had on student and faculty perceptions who are directly involved in that medical curriculum. The next chapter discusses the findings of this dissertation research and offers recommendations regarding the teaching and learning of the anatomical sciences in medical schools.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATION REGARDING MEDICAL EDUCATION REFORM AND ITS IMPACT ON THE TEACHING AND LEARNING OF THE ANATOMICAL SCIENCES

Medical education curricular reform has become a common occurrence in the last few decades. The previous chapters presented both quantitative and qualitative analyses on the research about how medical curricular reform has impacted the teaching and learning of the anatomical science courses of gross anatomy, microscopic anatomy, and neuroanatomy. These anatomical subjects have all been monumentally impacted by curricular reform, especially with having their hours reduced in the curriculum, which has been documented in previous research (Drake et al., 2002, 2009, 2014; McBride and Drake, 2018).

In part one of this chapter, there is a summary of the findings and analyses addressing the research questions of this study that investigated medical curricular reform and its impact on the teaching and learning of the anatomical sciences. In part two of this chapter, evidence-based recommendations regarding best practices in organizing a medical curriculum, with a focus on the anatomical disciplines, are presented. Part three acknowledges the limitations associated with this research, and part four discusses future directions that should be explored in the area of medical education reform. This chapter ends with final conclusions, summing up the entirety of this research.

Part 1: Summary of Findings and Analyses Addressing the Research Questions of this Study

The current status of curricular reform at allopathic medical schools in the United States has been described from the analysis of 147 medical school websites, 115 faculty survey responses, 17 faculty interviews and a case study completed at Indiana University School of Medicine-Bloomington (IUSM-B), including 26 student survey responses, a student focus group from IUSM-B, and a faculty focus group from IUSM-B.

The research questions and associated hypotheses are presented in Table 7.1. Below the table, the author discusses each research question and hypothesis pair individually. As a reminder, only the quantitative data findings are used to see if the data supports the hypothesis. Qualitative data serves to further inform the quantitative data and does not have a priori hypotheses associated with it.

Table 7.1: Medical School Curricular Reform Research Questions and Hypotheses

Research Number and Question	**Hypothesis**	**Does Data Support Hypothesis?**
1. How do American medical schools granting a medical doctorate degree classify their curricula?	Medical schools will have many different ways to classify their curricula. It is hypothesized that the term "integration" will be used most commonly, followed by the terms horizontal, vertical, and/or spiral curricular reform.	Yes, 91.8% of medical curricular websites (147) used "integration. Verbatim usage of "horizontal, vertical and spiral" in curricular descriptions was not commonly used. However, these terms were demonstrated regularly on curricular maps
2a. What numbers of allopathic medical schools in the United States have undergone any major curricular reform within the last 10 years (since 2007)?	The proportion of responses of medical programs that have undergone curricular reform in the last 10 years will be greater than those that have not.	Yes; 82.6% underwent curricular reform (95 of 115)
2b. What were the medical schools' stated reasons for curricular reform at their institutions?	The most common reason for curricular reform will be to meet the Liaison Committee on Medical Education (LCME) standards for accreditation.	No, but preparing for reaccreditation by LCME was second most common reason for curricular reform, after keeping up with current trend (most common response)
3. How are anatomical science classes organized within medical school curricula that have been recently revised?	Many of the anatomical sciences in majorly revised curricula will not be taught as stand-alone courses. Rather, they will be combined with another course or taught within a systems-based unit.	Yes, between 46-81% of faculty stated their anatomical discipline was organized by organ systems
3a. Does the anatomy content coverage increase, decrease or stay the same for classes involving the anatomical sciences?	The amount of time of instruction and number of topics related to gross anatomy topics, including lab and lecture, will be decreased in medical school programs that have undergone curricular reform. The amount of time of instruction and number of topics related to microscopic anatomy and neuroanatomy in medical schools that have undergone curricular revision will not change.	Yes, for amount of time for gross anatomy, 86% of faculty said it decreased; However, between 56-91% of faculty stated amount of time for microscopic and neuroanatomy decreased as well. For microscopic anatomy, 60% said number of topics stayed the same, though between 50-60% of faculty said number of topics decreased in gross and neuroanatomy

3b. How does the curricular revision change the amount of anatomy lab experience and type of lab experience in the anatomical sciences?	The amount of time dedicated to and type of lab experience in revised curricula will vary with medical schools and type of classes because no one size fits all.	Yes, many different types of lab activities used in the anatomical sciences.
3c. How does the curricular revision change the anatomy lecture experience in the anatomical sciences?	The lecture experience in a revised curriculum will include many varieties of active learning for all anatomical disciplines. Additionally, the lecture experience will change to a large extent in all anatomical disciplines, including having reduced hours.	Yes, between 45-55% of faculty stated that lecture in anatomical disciplines changed a moderate to large extent. Yes, many varieties of active learning were used in the lecture, including TBL and PBL. Also see explanation for research question 3a.
3d. What are faculty perceptions of curricular reform at their institution?	Faculty member perceptions of their revised medical curriculum will be strongly correlated with the amount of involvement they have had with the planning and development of the curricular reform. Additionally, faculty perceptions about the curriculum will be more strongly correlated in curricula that have been implemented for longer than five years.	Yes there was a significant association between extent of faculty involvement and perceptions overall of curriculum. There was no significant association between perceptions of length of time since implementation of curricular reform
4. What are medical student and faculty perceptions of curricular reform at a case study institution (Indiana University School of Medicine-Bloomington), and how do they compare to the US landscape?	Hypotheses are embedded within research questions 4a and 4b.	
4a. How do first-year medical students IUSM-B perceive the newly implemented medical curriculum that began in Fall of 2016?	Perceptions of students at IUSM-B about the medical curricular reform will skew slightly negatively.	Yes, mean of overall perceptions of curriculum, on a 1-10 scale was 5.08 $\pm$2.22

4b. How do anatomy faculty perceptions of curricular reform at IUSM-B compare to anatomy faculty perceptions from other US medical schools?	In general, anatomy faculty member perceptions of their revised medical curriculum will be strongly correlated with the amount of involvement they have had with the planning and development of the curricular reform.	Please see explanation for research question 3d

Research question 1 was, “How do American medical schools granting a medical doctorate degree classify their curricula (e.g., horizontal, vertical, or spiral integration, problem-based learning curriculum, basic science integration, organ-systems based, etc.)?” The first hypothesis for this research question was about how medical schools would have many different ways to classify their curriculum. From the data analysis that was completed in Chapter 4, it was found that there are indeed many ways that medical schools can organize and classify a medical curriculum. Organizing medical content in the pre-clerkship medical curriculum by organ systems was one of the most common classification descriptors. However, through the analysis of medical school websites, it was found that the description about organizing courses by organ systems was not the only information about the curriculum that was present. And upon looking closer at the curricular maps of the medical schools, it was found that medical schools most often organized their curricula by having 1-2 foundational courses early in the pre-clerkship curriculum and then a transition to organ systems-based modules.

The second hypothesis for research question 1 was that “integration” would be the most commonly used term in curricular descriptions. This hypothesis was found to be true, in that 91.8% of medical programs used the term “integration” somewhere in their curricular descriptions. In fact, there were thirteen different types of integration used in curricular descriptions. The terms of “horizontal,” “vertical,” and “spiral” integration were not explicitly used by medical school websites in the textual descriptions of the curriculum. However, review of curricular maps from the medical schools indicated that, in fact, many medical schools do indeed organize their curricula using horizontal integration, vertical integration, and spiral integration, even if those terms were not used on their websites.

Since these three integration terms were not used in the textual descriptions about the medical curriculum, they were not counted in the final tally of curricular descriptive terms. However, the author did make a note of some specific ways in which medical schools organized their curricula horizontally, vertically, and spirally. Please see Chapter 4 for an explanation of the use of these terms along with representative curricular diagrams from medical schools.

Research question 2a was, “What numbers of allopathic medical schools in the United States have undergone any major curricular reform within the last 10 years (since 2007)?” The hypothesis for research question 2 was that the number of medical schools that have undergone curricular reform would be greater than the numbers who have not. This hypothesis was found to be true, with 95 of the 115 survey respondents (82.6%) saying their medical school had undergone curricular reform in the last 10 years. And of the 20 respondents whose medical school had not undergone curricular reform, 8 (40%) stated their medical school was planning to undergo curricular reform within the next 10 years. When these data are combined, 103 (89.6%) of the 115 respondents stated their medical school had undergone curricular reform or were planning to undergo curricular reform in the near future. The data align with Association of American Medical Colleges (AAMC) and Liaison Committee on Medical education (LCME) 2017-8 medical school survey data, which showed that, of 147 medical schools that responded, 123 (83.7%) had undergone curricular reform or will undergo curricular reform within the next three years (LCME Annual Medical School Questionnaire Part II, 2017-2018). All of this data show that curricular reform is occurring at many medical institutions across the country, and it is unlikely to stop any time soon.

Research question 2b was "What were the medical schools' stated reasons for curricular reform at their institutions?" The hypothesis was that the most common reason for reform would be to meet the Liaison Committee on Medical Education (LCME) standards for accreditation. Per faculty survey responses, the most common response was to keep up with the current trend, followed by meeting LCME recommendations or preparing for reaccreditation. As all medical schools strive to keep their accreditation status (or receive accreditation upon the opening of a new medical school), this reason would be very important for revising a curriculum. Nevertheless, the primary reason for curricular reform was because other medical schools were also undergoing or had recently undergone curricular reform. This statement was evidenced by the numerous published reports within the past five years which described individual medical schools that have undergone curricular reform and how specifically they redesigned their curriculum (Brooks et al., 2015; Ginzburg et al., 2015; Heiman et al., 2018; Klement et al., 2017).

Research question 3 was, "How are the anatomical science classes organized within the medical curricula that have been recently revised?" The hypothesis for this question was that medical schools would no longer primarily teach their anatomical sciences as stand-alone courses. Per faculty survey respondents, the most common way to organize the anatomical sciences in a medical curriculum that had recently undergone reform was through systems-based courses. Fewer than 20% of the 115 respondents stated that their anatomical science course was a stand-alone course. These data supported the hypothesis for this research question.

Research question 3a was “Does the anatomy content coverage increase, decrease or stay the same for classes involving the anatomical sciences?” The hypothesis for this question was that the amount of time of instruction and number of topics related to gross anatomy topics would decrease, and for microscopic anatomy and neuroanatomy, the content coverage would stay the same. The results showed that in all three anatomical science subjects, the amount of time dedicated to teaching those subjects decreased. The number of hours decreased the largest for microscopic anatomy. There was a decrease in the number of topics taught for gross anatomy and neuroanatomy, but the number of topics for microscopic anatomy stayed the same after curricular reform. The data were also confirmed from the open-ended questions on the faculty survey, where respondents stated how the hours were drastically reduced by the reduction of the number of didactic lectures. For microscopic anatomy specifically, many respondents stated the labs were now completed by the students outside of class time. Faculty also stated much basic science information was now compressed in the curriculum; for instance, gross and microscopic anatomy were integrated into a single, one-semester course. Additionally, they stated there were not large chunks of material eliminated from the subject; rather, the level of detail in teaching the anatomical subject was reduced.

Research question 3b was “How does the curricular revision change the amount of anatomy lab experience and type of lab experience in the anatomical sciences?” while research question 3c was “How does the curricular revision change the anatomy lecture experience in the anatomical sciences?” The hypotheses for these questions stated how the lab experience would be variable in the medical schools, but the lecture experience would include many varieties of active learning approaches and have shortened course hours. It was found that there were many different activities to include in the lab portion of the anatomical science courses. For gross anatomy, cadaver dissection was still a prominent learning tool at most medical institutions. For lecture, many medical schools used a wide variety of active learning pedagogical methods in the anatomical science course. Lecture was still the primary delivery method of medical knowledge, but pedagogy such as team-based learning (TBL) and problem-based learning (PBL) were very common for each of the anatomical sciences. It was also confirmed that lecture changed from a moderate to large extent in all three anatomical sciences courses. Additionally, almost 80% of microscopic anatomy faculty who responded stated their lab changed to a large extent. One way in which microscopic anatomy lab changed greatly was the transition to out- of-class laboratory sessions, where students must learn the virtual microscopy structures on their own time. All these data confirm what was found previously by other surveys of anatomical science faculty (Drake et al., 2002, 2009, 2014; and McBride and Drake, 2018).

Research question 3d was "What are faculty perceptions of curricular reform at their institution?" The first hypothesis for this question was that faculty perceptions would be strongly correlated with the amount of involvement they have had with the planning and development of the curricular reform. This hypothesis was found to be true, though the correlation was found to be weak to moderate in strength ($r_s = 0.318$) when Spearman's correlation was performed on the data. The second hypothesis for this question was that faculty perceptions about the curricular reform would be strongly correlated with curricula that have been implemented for longer than five years. The author believed that the longer the curricular reform was around, the more the faculty would become accustomed to it (and thus not have as negative a view of reform as faculty who more recently experienced curricular reform). However, the data collected did not support this hypothesis. There was not a statistically significant relationship between those variables when a Chi square test of independent was performed ($\chi^2(8, n = 79) = 10.231$, $p = 0.249$). Additional findings about faculty perceptions of their medical curriculum showed that perceptions were more positive from those faculty whose medical school had not undergone curricular reform in the last 10 years. These data demonstrate how purely undergoing the act of curricular reform, and not having a focus specifically on what is going into the curriculum, may generate cynical feelings from those individuals who are teaching within the curriculum.

This research not only utilized quantitative data from surveys, but qualitative data from open-ended survey questions and interviews were also analyzed. This mixed methods analysis is important for this type of research for data triangulation, including assuring the validity of the research by using different data collection measures. However, this type of analysis also provides richer insights to answer the research questions, compared to using either quantitative or qualitative method alone (Creswell, 2012).

The qualitative thematic analysis of the data from the seventeen faculty interviews, which helped answer research question 3d, generated themes including, "There exists an overall administrative control of the curriculum," whereby faculty believed they do not have much control on what specifically goes into the medical curriculum. Another theme generated from the data was "The goal of the medical curriculum is to streamline the teaching and learning of the basic science information," and that this should be accomplished without sacrificing the quality of the education of the students. Curricular reform is nothing new, and the rates of it happening at the medical level appear to be consistent. Additionally, the amount of time dedicated to teaching the basic sciences, especially the anatomical sciences, will either continue to decrease or remain stagnant, with independent student learning becoming a more prominent method in medical education. The final theme was "Regardless of how the medical curriculum is structured, students will do what they need to do in order to succeed," where faculty stated how their students' USMLE Step exam scores did not change remarkably (either positively or negatively) due to curricular reform.

Research question 4a asked, "How do first-year medical students at IUSM-B perceive the newly implemented medical curriculum that began in Fall of 2016?" The hypothesis for this question was that IUSM-B student perceptions would skew negatively. This was found to be true because students' overall perceptions of the curriculum, on a 1-10 scale, had a mean score of 5.08 (SD = 2.22). Overall faculty perceptions on a 1-10 scale had a mean score of 6.78 (SD = 2.30). There was also an interaction between length of time since curricular reform and student satisfaction with the curriculum, as opposed to the lack of interaction of length of time since implementation and faculty perceptions. Medical students from the second cohort surveyed had more positive levels of satisfaction with the curriculum, though it was a very limited sample.

There were aspects of the IUSM curriculum that the medical students both enjoyed and did not enjoy, as evidenced by the thematic analysis of the focus group session. Students liked the pass/fail grading system of the new curriculum, saying that this grading system promotes less competition among the students, which confirms previous research on this topic (Bloodgood et al., 2009). The IUSM-B medical students also enjoyed when the curricular format made sense to them, including when there was deliberate integration of material, but often they felt there was a sense of disjointedness with the material. Students believed the curriculum was not fully thought out before it was delivered to them. They desired more transparency with the administration and faculty on what specifically will be occurring with the curriculum.

In previous research which analyzed student perceptions of curricular reform, much of the research has only shown the positive aspects of curricular reform. This finding was especially evident of reports of individual medical schools that revised their curricula. Or a report may have just described the implementation of a new learning activity into the revised curriculum and evaluated student perceptions about only that specific activity (Lazarus et al., 2014; McLean et al., 2018). There have been very few reports which have documented students' feelings about an entirely new medical curriculum by use of focus groups or interviews. The research from this dissertation helped fill in this gap to explain why students had the perceptions they did about the new medical curriculum at IUSM.

Research question 4b was, "How do anatomy faculty perceptions of curricular reform at IUSM-B compare to anatomy faculty perceptions from other US medical schools?" The hypothesis for this question was the same for the question 3d from above, which was that perceptions would be correlated with the amount of involvement they have had with the planning and development of the curricular reform. Additionally, faculty perceptions about the curriculum would be more strongly correlated in curricula that have been implemented for longer than five years. The IUSM-B faculty did not take the survey (that the author was aware of), so quantitative responses were not tracked, and qualitative responses from the focus group at IUSM-B do not generate a priori hypotheses. There were a few common trends between the IUSM-B faculty and faculty from other medical schools, through the analysis of the focus group conducted with IUSM-B faculty and interviews with the other faculty. These common trends included liking the integration of material, concern with the pass/fail grading system, and the administration having a major contribution in the design of the curriculum. However, IUSM-B faculty responses primarily focused on the standardization of the curriculum at IUSM, aligning all nine campuses together, which is a unique challenge of the medical curriculum at IUSM that does not apply to many other medical schools.

One major focus point of this research was to give medical school faculty members a formal voice in their experiences with and perceptions of curricular reform at their institution, as many of the past publications about curricular reform either were written by administrators or did not discuss in depth faculty opinion. There is a considerable lack of research regarding faculty perceptions of medical curricula. Feedback on the medical curriculum in constantly sought from students – not only in end of year evaluations but also though the surveys distributed by the AAMC. The AAMC Medical School Year 2 Questionnaire (2017) and Medical School Graduation Questionnaire (2018) survey medical students each year about their experiences with and perceptions of the curriculum. Additionally, there are multiple publications which addressed students' perceptions of their medical curriculum (Klement, 2017; Muller, 2008; Yengo-Kahn et al., 2017).

Part 2: Conclusions and Evidence-based Recommendations for Best Practices in Organizing a Medical Curriculum, with a Focus on the Anatomical Disciplines

Based on the data and evidence produced during the medical school website analysis, surveys and interviews with anatomical science faculty, and surveys and interviews with first-year medical students, this section contains suggestions and ideas for improving the organization and delivery of the medical curriculum, with regard to the anatomical sciences.

Conclusion 1: The medical school curriculum, and its reform, is primarily controlled by the administration, with minimal faculty input.

Recommendation 1: There needs to be increased faculty input in decision-making about the medical curriculum.

Based on faculty survey responses and interview analysis, one of the common topics that arose was about how the administration at the medical school is the primary decider on not only whether the medical school should undergo curricular reform, but how specifically it should do so. However, even the LCME (2018) states that faculty should have input,

> "A medical school has in place an institutional body (e.g., a faculty committee) that oversees the medical education program as a whole and has responsibility for the overall design, management, integration, evaluation, and enhancement of a coherent and coordinated medical curriculum" (Standard 8.1, pg. 12).

Standard 8.2 states,

> "The faculty of a medical school, through the faculty committee responsible for the medical curriculum, ensure that the medical curriculum uses formally adopted medical education program objectives to guide the selection of curriculum content, review and revise the curriculum, and establish the basis for evaluating programmatic effectiveness. The faculty leadership responsible for each required course and clerkship link the

> learning objectives of that course or clerkship to the medical education program objectives" (pg. 12).

Additionally, Standard 6.1 states,

> "The faculty of a medical school define its medical education program objectives in outcome-based terms that allow the assessment of medical students' progress in developing the competencies that the profession and the public expect of a physician. The medical school makes these medical education program objectives known to all medical students and faculty. In addition, the medical school ensures that the learning objectives for each required learning experience (e.g., course, clerkship) are made known to all medical students and those faculty, residents, and others with teaching and assessment responsibilities in those required experiences" (pg. 8).

The LCME is explicit in saying that faculty should be involved in the planning and development of the curriculum. A little over 50% of respondents to the faculty survey stated they were involved in the initial development of the curricular reform, but on the other hand, the majority of respondents stated that the administration had most of the control deciding what would go into the curriculum. A common trend to arise during the interviews was about administrative control of the curriculum, and faculty not having much control on what they teach, even though they are the experts on what to teach their students. However, one respondent to the faculty interviews stated how they were involved in the curriculum, but that the curriculum planning took over their time, making less room to focus on their teaching. There needs to be a balance between administrative and faculty involvement. Only around 30% of faculty stated there was equal faculty and administrative involvement in the curriculum design at their medical school. Medical schools should aim for this number to be higher.

Faculty should have their voices heard with regard to what should be taught in a medical curriculum. Again, the author is not advocating for complete faculty control of the curriculum, as faculty have many other responsibilities to attend to, including teaching the students and conducting research, but there needs to be an increase in faculty involvement throughout all steps of designing new or revising a current medical curriculum. There has been a considerable lack of research on faculty perceptions of their medical curriculum. Muller et al. (2008) interviewed three curriculum leaders, four course directors, and six students about the transition to a new curriculum at one medical school. Themes that emerged from the interviews included challenges such as interdisciplinary collaborations, overcoming the reluctance of transition to a new curriculum, and faculty communication. This study provided valuable insight into faculty views of curricular reform, but it is only one study, at one medical school, from over 10 years ago, compared to many others that sought student input on curricula. Another study by Velthuis et al. (2018) interviewed curriculum leaders at eight Dutch medical schools, but most of these curriculum leaders were deans and associate deans. Only a few faculty members who taught in the curriculum were interviewed.

Students may also have a desire to be involved in the curriculum. Scott et al. (2019) published a report about Harvard Medical School's Education Representative Program, which was launched alongside Harvard's new medical curriculum. The program stated it fostered partnerships between students and faculty for continuous curricular improvement. The student representatives sought feedback from their peers on course content, pedagogy, classroom dynamics, assessments, and their impact on learning. They also sought feedback from the faculty about student preparedness and engagement with the learning sessions. This is another way to get more people involved in a curricular design.

Mejicano et al. (2018) described a curricular revision that occurred at Oregon Health and Science University in 2014 that involved many stakeholders including various administrators and faculty. The authors created a list of best practices involving those stakeholders in implementing a new curriculum, including knowing when to compromise, expecting resistance (especially from senior faculty and administrators), having effective communication, and choosing leaders wisely.

The author realizes that not every single faculty member (or student) at a medical institution may want to be involved with the planning and organization of the medical curriculum. However, of those faculty who do wish to be involved, there needs to be a better avenue for them to do so. Most medical schools contain a curriculum committee, but how specifically is that curriculum committee involving the faculty? How much interaction is there between faculty and the Office of Medical Education at the institution? These are questions that both administrators and faculty should be asking themselves and attempting to rectify if there is a deficit in communication.

Haramati (2015) published a commentary piece about how medical schools can engage basic scientists who are interested in becoming more educated about the medical curriculum and assuming leadership roles in curriculum integration. In this article, the author outlined three components that institutions should adopt to better involve basic science faculty in integrating the medical curriculum: (1) offer opportunities to interested faculty to gain the necessary expertise to become skilled educators, such as encouraging them to join professional medical educational associations; (2) create a community of medical educators at the institution by encouraging basic science faculty and clinical faculty from different departments and centers across campus to work together; and (3) align institutional priorities and incentives to promote curricular integration, including recognition for implementing new learning activities in a classroom.

With the willingness of interested faculty to partake in curricular design and the strategies used by the administration to encourage and support those faculty, this cooperation has the ability to contribute to a dedicated workforce whose goal is the successful education of medical students.

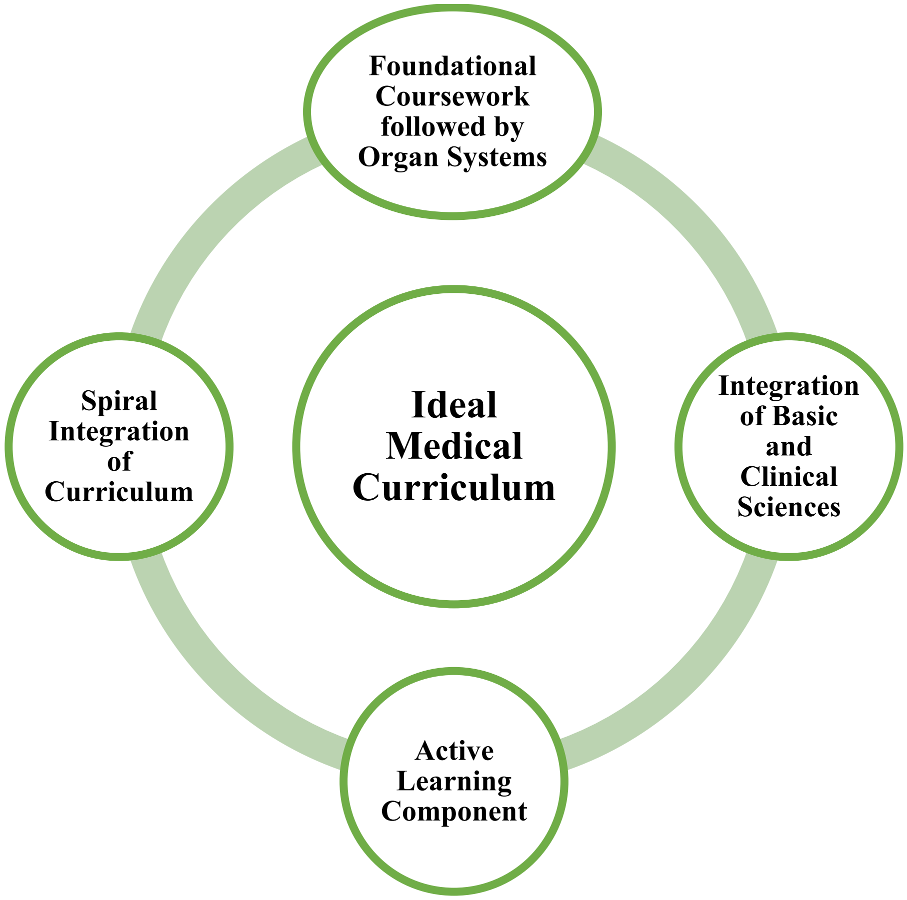
Conclusion 2: There is no one-size-fits-all approach to designing a medical curriculum, but there are ideal components that should be incorporated into the curriculum.

Recommendation 2: The ideal medical curriculum should include the following aspects:

- Integration of basic and clinical sciences in the medical curriculum.
- Spiral integration
- Basic sciences foundational courses taught in the beginning of the pre-clerkship medical curriculum, followed by organ systems-based blocks
- Active learning components throughout all courses in the medical curriculum

The conclusion and these recommendations were discussed at length in Chapter 4. The author will briefly mention the components again, along with citing some relevant research to support these recommendations. Figure 7.1 shows the curricular schema model from Chapter 4 that shows each of the four components of an ideal medical curriculum.

Figure 7.1: Medical School Curricular Schema Model



For the two recommendations which utilize the term "integration," (integration of basic and clinical sciences and spiral integration) it should be noted that the general term of "integration" is misused by many medical schools, or at least not fully established on how they integrated their curriculum. The definition of integration used by the author for this research is "the organization of teaching matter to interrelate or unify subjects frequently taught in separate academic courses or departments," (Harden et al., 1984, pg. 288). For "spiral curriculum," the author used the definition proposed by Brauer and Ferguson (2015): "a fully synchronous, trans-disciplinary delivery of information between the foundational sciences and the applied sciences throughout all years of a medical school curriculum" (pg. 318). In order to be truly integrated, courses must be carefully and collaboratively combined. Deliberate collaboration among basic science and clinical faculty must occur. Harden (2000) developed a model on which to help educators plan, develop and implement an integrated curriculum. This model may be seen in Figure 7.2. From the figure, Step 1 begins at the bottom with Isolation and then moves toward the top with Step 11 as Trans-disciplinary. Each of the steps are referenced below.

- Isolation = organization of discipline-specific material without consideration from other disciplines; e.g., teaching stand-alone courses

- Awareness = educator in one discipline is made aware of what is taught in another discipline; e.g., communication but lack of coordination

- Harmonization = educators from different classes/disciplines communicate what they are teaching their students; e.g., increased communication among educators but not quite coordinating topics yet

- Nesting = educator targets skills related to another discipline; e.g., discussing the procedure of a pericardiocentesis when lecturing on the anatomy of the heart

- Temporal co-ordination = timing of teaching topics in a discipline is coordinated with other disciplines; e.g., discussing the gross anatomy and microscopic anatomy the nervous system at the same time but in separate courses

- Sharing = educators from two disciplines plan and jointly create a teaching program; e.g., set learning objectives for microscopic anatomy and gross anatomy sessions on same topic, but still separate courses

- Correlation = integrated teaching session is introduced, but separate disciplines are still taught; e.g., gross anatomy session on female reproductive system may occur, followed by microscopic anatomy session on female reproductive system in same class period

- Complementary Programme = integrated sessions are major feature of curriculum, but some disciplines are still taught separately; e.g., gross anatomy and microscopic anatomy are integrated together but neuroanatomy/neuroscience taught on its own

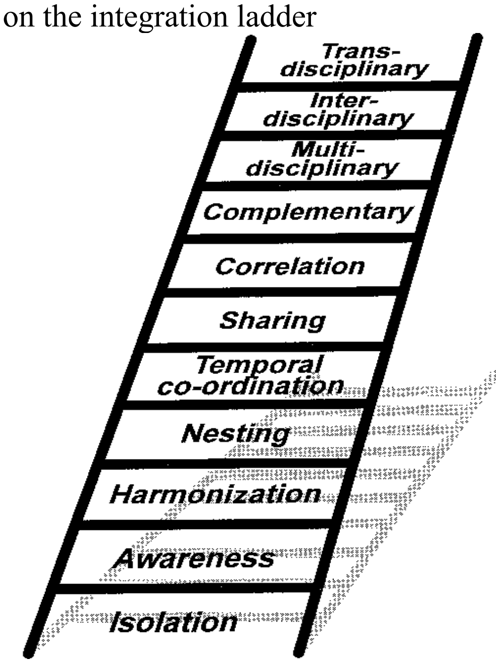
- Multi-disciplinary = multiple disciplines are brought together in single course with common themes and topics; e.g., beginning of organ systems-based units

- Inter-disciplinary = further shift to themes as a focus; e.g., better coordination among topics and disciplines within organ systems-based units

- Trans-disciplinary = curriculum fully transcends individual disciplines. Harden (2000) describes this step as where the integration is completed in the mind of the student, for instance, during the clerkship phase of the medical curriculum in order to help diagnose a patient who comes into the clinic with abdominal pain.

The author suggests that medical schools utilize this model to survey their own curriculum and assess if it is fully integrated.

Figure 7.2: The 11 steps on the integration ladder



From Harden, 2000

This figure shows the 11 steps an educator can follow to plan, develop and implement an integrated medical curriculum.

Malik and Malik (2011) wrote a research report that contained guidelines for developing and integrating a medical curriculum. These authors proposed 12 tips to follow for developing an integrated curriculum. A few of these steps included train staff members (Tip 1), determine learning outcomes (Tip 6), select assessment methods (Tip 10), and commit to re-evaluation and revision (Tip 12). The author will not go into depth on the scope of the medical curriculum as these two authors did with their report; however, there is a recognition of the usefulness of these tips in assisting those making curricular decisions for their medical school. The following paragraphs will discuss the components of the curricular model created by the author.

As was evidenced from data findings and analysis in Chapter 4 of this research, the 147 allopathic medical programs in the United States have many ways in organizing and classifying their medical curriculum. Standards from LCME only state a few items regarding organizing a medical curriculum. The rest of the curricular organization is usually decided upon by administrators and the curriculum committee at the medical school. One of the standards from the LCME (2018), related to how the content should be organized, states, "The faculty of a medical school ensure that the medical curriculum includes content and clinical experiences related to each organ system…" (Standard 7.2, pg. 10).

While most medical programs organized the curriculum by organ systems, some did not. However, that may change in the coming years with more schools wanting to align with these standards. LCME only completes site visits every eight years (LCME, 2018), and so it may be another few years before medical schools are thinking about changing their curriculum again to better coordinate with LCME standards.

Another standard about the organization of a medical curriculum describes how a medical program must be "coherent and coordinated" (LCME, 2018). From the glossary of terms used in the standards:

> "Coherence and coordination include the following characteristics: 1) the logical sequencing of curricular segments, 2) coordinated and integrated content within and across academic periods of study (i.e., horizontal and vertical integration), and 3) methods of instruction and student assessment appropriate to the achievement of the program's educational objectives (Element 8.1)" (pg. 22).

Additionally, students must engage in problem-solving skills and critical thinking within the curriculum (Standard 7.4):

> "The faculty of a medical school ensure that the medical curriculum incorporates the fundamental principles of medicine, provides opportunities for medical students to acquire skills of critical judgment based on evidence and experience, and develops medical students' ability to use those principles and skills effectively in solving problems of health and disease" (pg. 10).

While many of these standards tell medical schools what must be included in the curriculum, the LCME does not explicitly say how these items should be incorporated. This sentiment contributes to the conclusion of that there is not a one-size-fits-all approach to designing a medical curriculum. However, there are important aspects to include in a medical curriculum so that students receive not only enough medical knowledge to pass their USMLE Step exams, but also so that they can utilize the skills they learn in medical school and apply them in their residencies and beyond.

Integration of the basic and clinical sciences is one important feature of a medical curriculum. Through this process, students learn the scientific principles and discover the clinical relevance of this information before students are in their clerkship period. Additionally, students should have access to clinical experiences in the first two years of the medical program. It is important for students to not wait until their third year to see patients (Cooke et al., 2010).

Not only should the medical curriculum integrate the basic and clinical sciences, but there should be integration of the curriculum at all levels, referred to as spiral integration. Please see Chapter 4 for definitions and examples of medical curricular maps for vertical, horizontal, and spiral integration. A spirally-integrated curriculum can revisit core concepts at periodic intervals throughout the medical curriculum. Densen (2011) stated that a spiral curriculum can encourage collaboration among basic science and clinical faculty, course directors, and the administration at large in order to allow for a cohesive curriculum to be run. Many medical schools may say they have a spirally-integrated curriculum, but one thing they should be asking themselves is what was just stated above – how involved are each of the stakeholders (faculty, clinicians, administrators) in the design and planning of the curriculum? Are faculty invested in their students past the pre-clerkship years (e.g., by offering a fourth-year elective)? How receptive are administrators to faculty and clinician involvement in the curriculum? These are questions that need to be asked of everyone involved (and those who wish to be involved) in the medical curriculum. As was mentioned in Chapter 4, this dissertation primarily focuses on the anatomical science courses and the pre-clerkship curriculum, so the author will not discuss much past the pre-clerkship years.

For the pre-clerkship medical curriculum, the author recommends that medical schools first teach fundamental concepts, particularly gross anatomy, embryology and microscopic anatomy, as foundational courses. After these foundational courses, the curriculum may then progress to teaching information through organ systems-based modules. This recommendation is both from LCME standards (2018) and also from the fact that medical students arrive in medical school with a wide variety of background knowledge, as described by Cooke et al. (2010). Students have to take certain pre-requisite courses in the areas of biology, chemistry, physics, and mathematics, but students may have a background in another area of focus. That is why it is important for medical curricula to organize their content into foundational courses in the beginning of the medical curriculum, rather than jumping right into organ systems units.

Four of the five articles mentioned above about how specifically a medical school has undergone curricular reform (Brooks et al., 2015; Ginzburg et al., 2015; Heiman et al., 2018; and Klement et al., 2017), revised their curricula so that gross anatomy was taught in a foundational basic science course in the beginning of the medical curriculum, and then later revisited in organ systems modules. Ransom et al. (2017) only discussed introducing PBL modules into the gross anatomy course and did not mention how the rest of the curriculum was organized.

Brooks et al. (2015) mentioned how gross anatomy and embryology are integrated into a course called Fundamentals I at the University of Alabama School of Medicine. Those subjects are also integrated with biochemistry, genetics, cell biology, and histology. This course is taught in the first semester of the first year of the medical program. Gross anatomy is then further integrated into organ systems modules taught in the second year of the medical curriculum. The authors stated that initially there was no gross anatomy until the students reached the organ systems modules, and that their scores on the USMLE Step 1 Exam related to gross anatomy information were very low. The medical school decided to place foundational gross anatomy information into the

Fundamentals course so that students would be exposed to that content early on and then be able to revisit it when discussing the specific organ systems. In addition to the integration of fundamental material early in the curriculum, the University of Alabama medical school has 3^{rd} and 4^{th} year anatomy and embryology electives, demonstrating how the curriculum is spirally integrated.

Ginzburg et al. (2015) presented upon the Hofstra North Shore School of Medicine, which is a different type of curriculum, but it still has the same framework as the author suggests: teaching foundational material early in the medical curriculum and teaching material through organ systems modules afterwards. At Hofstra, foundational medical knowledge is taught first in a module called "From the Person to the Professional: Challenges, Privileges, and Responsibilities." Students in this module receive an overview of the organ systems, but they also learn information related to the form and function in health and disease. Additionally, the first two years' worth of modules of the medical program are divided into themes. For example, one module in the second semester of the program is entitled "Continuity and Change: Homeostasis." Within this module, the cardiovascular, pulmonary, and renal systems are discussed.

Didactic lectures alone do not engage students in conceptual understanding of medical knowledge (Cooke et al., 2010). Survey results from this research have shown that many medical schools that have undergone recent curricular reform are utilizing a variety of active learning strategies in the medical curriculum, including PBL, TBL, flipped classrooms, and case-based study. Non-didactic learning sessions can foster both activation of prior knowledge and active knowledge construction in novel scenarios the students may encounter (Schmidt et al., 1989), encouraging problem-solving and critical thinking skills.

Freeman et al. (2014) conducted a meta-analysis with 225 studies that reported student performance data in undergraduate STEM courses using active learning or traditional didactic lectures. The authors found that average examination scores increased by 6% in courses that used active learning. Additionally, it was found that students in courses that only used traditional lectures were 1.5 times more likely to fail the course. It's not just medical school where active learning sessions are vital. Many students studying many subjects benefit from these sessions.

Problem-solving and critical thinking skills were found to be very important by faculty interview respondents from this research. One question that was asked of them was "What is the point of curricular reform?" Since multiple studies demonstrated that the type of medical curriculum had no significant impact on USMLE Step scores (Cuddy et al., 2013; Hecker and Violato, 2009), the author desired to know why medical schools were undergoing curricular reform. Additionally, the author asked of the faculty interviewees, "How do you measure student success in medical school?" Again, the author was trying to understand what else (other than Step scores) could be reviewed to assess what a curriculum is doing for its students. Many responses elucidated feelings about how the medical curriculum was assisting students with developing problem-solving and critical thinking skills through these active learning strategies. This topic is further discussed under Conclusion and Recommendation 3.

As far as what specific medical schools have done to incorporate active learning strategies into their curricula, Brooks et al. (2015) stated the University of Alabama

School of Medicine replaced a few didactic lecture sessions with TBL sessions in the Fundamentals I course and in some of the organ systems modules. The authors stated that students followed a normal TBL protocol where students complete preparatory materials (in this case, a pre-recorded video and PowerPoint presentation). The TBL then begins with an individual readiness assessment test (IRAT) and then a group readiness assessment rest (GRAT) on the material the student should have prepared for. The rest of the session involves appeals (request for retraction of a multiple-choice question if the student feels it was coded incorrectly or poorly written), instructor and peer feedback, and application exercises (Team-based Learning Collaborative, 2019). The students groups are the same as cadaver dissection groups which allows for greater team-building skills (Brooks et al., 2015).

For the Hofstra School of Medicine (Ginzburg et al., 2015), there is a thread integrated throughout the first two years called “PEARLS” which stands for Patient-centered Explorations in Active Reasoning, Learning and Synthesis. It is a hybrid case/problem-based learning program which helps students develop teamwork and critical thinking skills. In these PEARLS sessions, students develop biomedical, clinical, and social science objectives that are explored in small group discussions as well as in complementary sessions, including large groups, labs, and multidisciplinary practice-based initial clinical experiences (ICE).

One can look at the research presented by Brooks et al. (2015) and Ginzburg et al. (2015) and believe that they have very different curricula. But at the core, they both have the fundamental components of a medical curriculum presented in Figure 7.1. These two medical programs are prime examples of having these fundamental components but also have their own unique curriculum, further illustrating the point that there is no one-size-fits-all approach to designing a medical curriculum.

Conclusion 3: Curricular reform has drastically reduced the number of course hours dedicated to teaching the anatomical sciences, but there has also been an increased focus in independent student learning and active learning in the classroom.

Recommendation 3: The goal of the medical curriculum should be to efficiently deliver basic science and clinical medical knowledge to the students, without sacrificing the quality of the education.

With the increased amount of medical knowledge overall, resulting in less time to teach some of the intricate details of each basic science subject (Densen, 2011) and the increased focus on incorporating independent student learning in the medical curriculum (LCME, 2018), medical curricular reform is at a unique place where it has to balance the quantity of medical information delivery with the quality of the education.

This research has shown that the lecture and lab hours in the anatomical sciences have been reduced in medical schools that have undergone recent curricular reform. These disciplines are now often integrated with other subjects and incorporated into organ systems-based units. The medical curriculum also integrates active learning methodologies into the courses, and it makes time for independent student learning. LCME Standard 6.3 (2018) explicitly states that the medical curriculum must include the following components:

> "The faculty of a medical school ensure that the medical curriculum includes self-directed learning experiences and time for independent study to allow medical students to develop the skills of lifelong learning. Self-directed learning involves medical students' self-assessment of learning needs; independent identification, analysis, and synthesis of relevant

> information; and appraisal of the credibility of information sources" (pg. 8).

The usage of the term "self-directed learning," however, is not the definition that other authors have used previously for independent student learning. Husmann et al. (2018) proposed that the term *self-regulated learning* be used instead, especially regarding medical students during their pre-clerkship medical education. Self-regulation is the process by which individuals plan their learning activities, set goals, and monitor and evaluate their own learning progress (Zimmerman and Schunk, 2001). Self-directed learning, on the other hand, is

> "a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, 1975, pg. pg. 18).

An example of a *self-regulated learning* activity at IUSM-B is student completion of out-of-class virtual microscopy labs, which began in fall 2017. While the labs and the learning objectives are developed by the faculty, students have only slight direction in how to learn the microscopic anatomy information from the virtual microscopy slides, and they must plan out their study time to learn that information prior to the examination. In contrast, an example of *self-directed learning* is a dissertation project. The graduate student typically selects his or her topic, develops a research plan and researches that topic, and presents results on the topic. The student may receive slight guidance from an advisor, but the bulk of the project is completed by the graduate student.

Independent student learning and active learning strategies in the classroom are vital components of the medical curriculum. The quality of medical education should be a primary focus, over the number of hours medical students spend learning material. Tools such as pre-recorded lectures can take the place of in-person didactic lectures, allowing for more quality classroom time engaging in small group work and having team-based discussions of clinically relevant material. The author is not promoting elimination of didactic lectures by any means, but medical educators should know that reduced time dedicated to the basic sciences, especially the anatomical sciences, is not a death sentence for those disciplines. Students are still able to acquire adequate information of those disciplines if the delivery of the material is done in a meaningful way. For example, McLean (2018) flipped her medical histology course and blended it with the general problem-based learning curriculum at the institution. Medical students watched pre-recorded videos and viewed a PowerPoint presentation prior to coming to class. In class, students answered multiple choice questions and then discussed relevant questions in groups of 2-3 and used clickers to answer those questions. Overall perceptions of the flipped classroom were positive.

Active learning and independent student learning, as well as the four concepts which make up an ideal medical curriculum, from Figure 7.1, are devised from the field of cognitive psychology. A fundamental concept of cognitive psychology is that the organization of knowledge is best when that organization matches the way in which the knowledge is used (Ambrose et al., 2010). In the domain of medical education, with integration at all levels of the medical curriculum, educators should make explicit connections among concepts through the integrated presentation of material, including placing basic science knowledge in the context of clinical examples. The idea of this cognitive theory concept, and of integrating the curriculum at all levels, is the promotion of long-term retention of material past the students' pre-clerkship years and into their residencies.

Retention of medical knowledge, especially anatomical medical knowledge, is an issue of concern for medical students entering their clinical years – especially their surgery rotations. Jurjus et al. (2014) found anatomical knowledge retention rates for students in their General Surgery and OB/GYN rotations was only around 50%, from scores on a multiple-choice test. The authors stated that in order to retain knowledge, students must engage in (and educators must encourage) actively searching for meaning in the material. Students need to allow their learning to transcend rote memorization and engage in deeper learning of the material.

Ways in which students can increase their knowledge retention include retrieval practice, where students recall information from memory through questions or testing (Karpicke and Aue, 2015). This retrieval may be accomplished when students study for the USMLE Step exams, such as when they take practice exams. However, this can also be accomplished through TBL sessions. Emke et al. (2016) implemented TBL into their medical curriculum to test for long-term retention of knowledge, compared to their traditional curriculum. The authors found that there was initial retention of knowledge, but the effect did not last until the students' clerkship years. The authors proposed an increase in repeated retrieval practice for the students to achieve the goal of long-term retention.

Another way in which students can increase their knowledge retention is through spaced practice. This is the practice of distributing shorter learning sessions over a longer period of time (National Academies of Sciences, Engineering, and Medicine, 2018).

Much of the research involving spaced practice and medical education involves continuing medical education (CME), which is the education physicians receive to maintain, develop, or increase the knowledge, skills, and professionalism to provide services to patients, after they complete their medical school and residency education (Accreditation Council for Continuing Medical Education, 2019). While this dissertation primarily discusses the pre-clerkship medical curriculum, CME is an important aspect of knowledge retention. Medical students will not remember everything that was learned in medical school, even with deliberate integration and active learning pedagogies employed in the curriculum. That is why CME is a vital aspect of lifelong learning in the medical professional, defined as "learning throughout the lifespan," particularly in adulthood (Jarvis, 2004, pg. 281).

An additional way in which students can increase knowledge retention is through interleaving. This is the practice of including different skills, activities, or problems within a learning session (National Academies of Sciences, Engineering, and Medicine, 2018). Interleaving works best when students are actively involved in the learning process, as opposed to being passive learners. Put another way, when students are sitting in the classroom listening to a lecture, they are often learning passively. However, when a student creates a concept map, draws out a pathway from memory, or discusses his or her thought process on trying to solve a problem – that is more active learning. Including these active learning strategies in the classroom is one way to increase retention of the material. (Gottlieb et al., 2017) reflected on a near-peer teaching program implemented at a medical school, which allowed for the process of interleaving to take place. Near peer teaching is a process where, in medical education, upper level medical students may help teach first-year medical students. For Gottlieb et al. (2017), fourth year medical students assisted second-year medical students in a Respiratory Pathology course. In surveys that were distributed to both the fourth- and second-year students, it was found that the second-year medical students enhanced their understanding of the material, and the fourth-year medical students believed the near-peer teaching program helped them self-reflect and improve upon their own teaching skills.

Not only should medical educators be deliberate with the methods used for knowledge delivery to their students, but they should also know what knowledge they should be delivering, both in the pre-clerkship period and during the clerkship period of medical education. The anatomical sciences are disciplines where that statement holds much truth. These are the subjects that have been documented not only from this research but also from other research (Drake et al., 2014; McBride and Drake, 2018) to be immensely affected as a result of curricular reform. One of the primary questions related to the teaching of the anatomical sciences is what should be taught and when?

The American Association of Anatomists (AAA) has developed new competencies for the anatomical sciences. A task force made of 60 members of the AAA was formed to create a new set of objectives while emphasizing the clinical relevance of the anatomical disciplines for the pre-clerkship curriculum. One of the goals of these new objectives was to distinguish topics that were important for students to master in the pre-clerkship years, versus topics that students could wait to learn in their clinical years. The final set of competencies were reviewed by the AAA's Educational Affairs committee and became available for the entire AAA community to view in early 2019. One example of a competency for gross anatomy was over the musculoskeletal system, and specifically the types of joints. The learning objective stated the students should be able to "Distinguish the three basic structural types of joints (fibrous, cartilaginous, synovial)." The clinical relevance of the competency was for the evaluation of joint pain. A note attached with the learning objective distinguished what medical students should know during the pre-clerkship curriculum versus what they should know during the clinical curriculum: "Detailed knowledge of the classification of joints (e.g., syndesmoses, condyloid) has limited relevance to most fields, thus discussion could be delayed until clinical training" (AAA, 2019, pg. 3). These competencies are very useful tools for deciding what information related to the anatomical sciences should be placed at what level of the medical curriculum, and the author highly encourages medical educators and administrators to review these objectives as they are designing or revising their medical curriculum.

The development of resources that show what content should be taught in the pre-clerkship curriculum is not unique to just the anatomical science disciplines. One study showed how a group of five medical schools banded together to form the Robert Wood Johnson Foundation Reimagining Medical Education collaborative where they agreed and defined core content for microbiology and immunology basic medical knowledge (Chen et al., 2019). Additionally, even though the anatomical disciplines have been widely documented to be affected by curricular reform, other basic sciences have also been altered due to a curricular revision (Gade and Chari, 2013; Sadofsky et al., 2014; Zgheib et al., 2010).

The organization and delivery of basic science content in the pre-clerkship years of medical education is an every-changing process, and it's not specifically unique to the anatomical sciences. Care should be taken when designing the best ways to teach the information, especially in the face of reduced contact hours and increased active learning strategies. It is vital for the students to have a quality medical education so that they become capable physicians.

Part 3: Study Limitations

While attempts were made to minimize confounding factors and potential sources of bias, this research still has its limitations. The limitations that will be discussed include the generalizability of results, survey design and validation, sample size of respondents, and inter-coder reliability with the qualitative data. The author discusses each of these limitations individually.

Generalizability

The case study at IUSM-B and the survey and focus group of first-year medical students from that institution cannot inherently be generalized to the wider population of medical schools and medical students. However, with rich descriptive text, one can evaluate whether these results are transferable to other medical schools and medical students. There were common trends found between IUSM-B and other medical schools. These common trends included the reduced hours dedicated to teaching the anatomical sciences, implementation of more active learning strategies, such as TBL, and the transition of the second year of medical school to include organ systems modules.

Survey Design and Validation

Chapter 3 of this research mentioned how the faculty and student surveys took steps towards validation. The author mentioned how the faculty survey went through many iterations. One of the iterations was initially distributed for recruitment for the study, but, after the author received feedback on it from some of the participants, the survey had to be rewritten and sent out a second time. For that iteration of the survey, some faculty taught in more than one anatomical discipline but did not fill out survey information about the other anatomical disciplines. The author attempted to contact the faculty directly to ask them to fill out that information, but that was only able to be completed if the faculty provided their contact information, which was an optional choice.

Additional survey design issues included faculty who responded that their medical school had not undergone recent curricular reform not being able to answer any other question related to the anatomical sciences. The author developed the survey in this manner because she wanted to see how the anatomical science courses changed due to curricular reform. But during the data collection and analysis process, there was a realization that faculty whose medical school had not undergone curricular reform would also be able to provide valuable data on how their anatomical science courses were organized in the medical curriculum. This thought was not registered until it was too late in the process of data collection, but if the survey was to be remade, the author would include the ability for any anatomical science faculty member to answer those questions.

Other survey issues included the anatomical science faculty not being able to quantify how the changes in amount of time dedicated to teaching the disciplines and number of topics. The survey only allowed them to choose an option of increased, decreased, or stayed the same.

One of the major benefits in mixed methods research is the ability for data triangulation. Simply put, triangulation is the comparison of findings about the same research questions using different inquiry methods which improves the validity of the survey (Bergman, 2008). Similar trends were found among the quantitative survey data, the open-ended survey data, and the interview data. While data triangulation cannot provide guaranteed truth of the data, it can help improve the validity of the collection tools by providing evidence of agreement and understanding of the data.

Sample Size

Seventy-nine different medical schools were represented in the faculty survey, which is 54.5% of all allopathic medical schools in the United States. As the total number of US anatomical science faculty at allopathic medical schools is not easily known, it is unknown how the total number of faculty respondents (115) compared to the total number of anatomical science faculty at allopathic medical schools in the United States. Faculty survey respondents who taught gross anatomy far outnumbered those who taught microscopic anatomy and neuroanatomy. This discrepancy in faculty sample sizes may be due in part to the recruitment methods. Neuroanatomists and cell biologists may not be as likely as gross anatomists to join the AAA or American Association of Clinical Anatomists (AACA), and instead join other societies that correspond to their research interests. The author did contact the listserv of Association of Anatomy, Cell Biology and Neurobiology Chairpersons (AACBNC), but that recruitment measure did not reach as many individuals as the other measures did.

The sample size for student survey respondents was lower than desired. Only 26 of 72 medical students (36.1%) from both cohorts answered the survey. The author could have made more of an effort to contact medical students, but she had already sent out two email messages requesting student participation in the surveys for each cohort. Medical students are constantly given surveys throughout their tenure in medical school, and so they may have experienced survey fatigue. Survey fatigue is defined as the time and effort required to participate in a survey with overexposure to the survey process leading to diminished response rates (Porter et al., 2004). As the survey was distributed after the students had completed the first year of their medical program, they may have not desired to take another survey, leading to the low response rates. Future attempts at surveying medical students should encourage a small incentive for study participation (e.g., small cash prizes or a gift card of $5, university apparel, or coupons for coffee). A study by Royal and Flammer (2017) found that health professional students are more likely to respond to a survey when multiple small incentives are offered. The incentive of pizza and soda was provided to medical students who participated in the focus group session, and that may have contributed to a little over 50% of the entire class contributing to the focus group session.

Inter-coder reliability

The author was the only person to transcribe, code, and analyze the qualitative data. With the time constraints of this project and having to be familiar with the data, it would not have been feasible to have another person code the entire dataset. For projects where more than one person is involved in coding and analyzing the data, inter-coder (or inter-rater) reliability should be employed. This process involves assigning a Kappa statistic from -1 to +1 on the extent of agreement between the coders (McHugh, 2012).

As part of the validation process for the qualitative interviews, member checking was used. This is a procedure which helps ensure trustworthiness with the data and conclusions (Guest et al., 2011). The author emailed transcripts and preliminary coding results to the faculty who participated in the interview process, along with a memo about the purpose of the study. Each interviewee was reminded that all data in the final analysis process would be anonymized, but that this member checking was to ensure that the data was analyzed correctly. Of the 17 interviewees, 7 responded to the author confirming that the analysis of their interview was accurate.

Part 4: Future Directions

This research has shown that the use of mixed methodologies may help answer pertinent questions related to medical education reform and its impact on the anatomical sciences. Since one of the research questions related to faculty perceptions of the medical curriculum, solely relying upon quantitative data to answer it would not have provided a full understanding of this area of research. The author expresses the need for more mixed methodology research to delve deeper into research that requires multiple points of view. Through the future directions that the author desires to take with this research, the author hopes to continue to use mixed methodology approaches.

The following is only a small sample of future projects the author desires to undertake. Many projects will require collaboration with other researchers, and the author looks forward to launching these projects in the future.

Curricular Reform Assessments

As has been stated multiple times in this report, studies have shown that relying only upon USMLE step scores to assess curricular reform is not a reliable measure (Cuddy et al., 2013; Hecker and Violato, 2009). However, there is a need for some type of assessment to look at fair comparisons among medical programs. Medical schools may look at knowledge retention by using multiple choice format tests in the students' clinical years (Jurjus et al., 2014; Malau-Aduli et al., 2013), but there are many confounding variables in those analyses. The author is not currently proposing any one way to research the right assessment tools of curricular formats; rather, the author desires to research this topic further.

Medical School Demographic Comparisons of Curricular Reform

As was alluded to in Chapter 4, more detailed comparisons are needed regarding the size of the medical school and the curriculum implemented at those schools. Are there specific trends in large-sized medical schools versus smaller medical schools? Are there trends in medical schools located in different areas of the country? These are topics that the author would like to research in the future, and this can easily be accomplished because the author already has much of the data already.

Comparison of faculty and administrator perceptions about medical curricular reform

As this research primarily sought information from anatomical science faculty about the medical curriculum at their institution, there is also a desire to systematically survey and interview administrators at those same institutions. As has been documented countless times in this research, the administrators have a major control over the design and planning of the medical curriculum. The author can ask questions related to the reasons for undergoing curricular reform, the actual revision process, and the administrator perceptions about curricular reform. These responses can be compared and contrasted with the faculty responses.

Additionally, the author would like to personally visit more medical schools and talk with faculty and administrators about curricular reform. Limited information may be extracted from website data and surveys of select faculty, so site visits are preferred.

Survey medical students from multiple institutions about medical curricular reform

Additional surveys which the author would like to administer also include gathering survey data from more medical students across the nation. The IUSM-B students provided valuable data for this research, but it would be beneficial to know how other medical students perceive their curricula. The author can compare and contrast those results with the results from the IUSM-B students.

Additionally, medical students can be surveyed throughout all years of their medical career and into their residency programs. It would be valuable to know in what way their medical school curriculum has prepared (or not) the medical students for entrance into their clinical years and beyond. This feedback from medical students can then be used to continue formulating guidelines for curricular reform processes.

Examine medical curricular reform's impact on other health professional programs

Finally, the author desires to see how curricular reform has impacted other health professional programs, including osteopathic medical schools, physical therapy schools, and dentistry schools. It would be a commendable idea to compare allopathic medical school curricular reform with curricular reform from other health professional programs. There is a great need to see how these programs have changed in the last decade. Or if these programs have not changed, there is a need for research on why they have not done so.

Final Conclusions

This research sought to provide extensive quantitative and qualitative data about medical curricular reform and its impact of the teaching and learning of the anatomical sciences. While much of this research has confirmed what was found by other studies, this research is among the first to examine the subject across the entire United States, across several medical schools, and collect extensive data from anatomical science faculty and from medical students. The data have shown that the anatomical sciences are greatly impacted by curricular reform, such has having their contact hours reduced; however positive aspects have also come from curricular reform. Active learning strategies are now commonplace, students are learning clinical information early in their medical career, and students' USMLE Step exam scores have not been adversely impacted by the curricular change.

However, research in the area is not complete. While students' Step exam scores have not significantly changed, there are still important aspects of the medical curriculum to consider: are students retaining their medical knowledge into their residencies? Is their medical education preparing them enough to become competent doctors? These are the areas in which future medical curricular reform research should strive to understand.

Appendix A

Table of allopathic medical schools' contact information and curricular code, organized by state

Total Student Population numbers from American Association of Medical Colleges, 2017-2018

https://www.aamc.org/download/321526/data/factstableb1-2.pdf

Institution and Website address	State Abbr.	Total student pop.	Coding of curriculum per website
University of Alabama School of Medicine, Birmingham, Tuscaloosa, Huntsville, and Selma https://www.uab.edu/medicine/home/medical-education/undergraduate-medical-education/curriculum	AL	806	Birmingham campus: 1,5 A,B,E,H Other campuses just have 3rd and 4th year there
University of South Alabama College of Medicine, Mobile https://www.southalabama.edu/colleges/com/currentstudents/resources/curriculum-schematic.pdf	AL	302	1,8,12 A,B,E ii
University of Arkansas for Medical Sciences, Little Rock and Fayetteville https://medicine.uams.edu/wp-content/uploads/sites/7/2018/07/1805125-BOOK-COM-2018-2019-catalog_FINAL.compressed.pdf	AR	711	Little Rock: 1,12,13 A,B,C,E Fayetteville campus for 3rd and 4th years
The University of Arizona College of Medicine, Phoenix http://phoenixmed.arizona.edu/education/admissions/md-curriculum	AZ	331	A,B,E i
The University of Arizona College of Medicine, Tucson http://www.medicine.arizona.edu/education/md-program	AZ	518	1,11 A,B,E i
California Northstate University College of Medicine, Elk Grove http://medicine.cnsu.edu/education/overview	CA	243	1,11 A,B,G,I i Curriculum is based on Clinical Presentation

David Geffen School of Medicine at UCLA, Los Angeles http://medschool.ucla.edu/current-curriculum	CA	845	1,13 B,E,G,I 5 year MD/MPH, MD/MBA or MD/MS option within Charles R. Drew/UCLA PRIME program
Keck School of Medicine of the University of Southern California, Los Angeles, CA http://keck.usc.edu/education/md-program/curriculum/		792	1,6,12 A,B
Loma Linda University School of Medicine, Loma Linda http://medicine.llu.edu/education/medical-student-education/curriculum	CA	717	D
Stanford University School of Medicine, Palo Alto http://med.stanford.edu/md/discovery-curriculum/pre-clerkship-resources.html	CA	516	1,6 B
University of California- Davis School of Medicine, Sacramento http://www.ucdmc.ucdavis.edu/mdprogram/curriculum/overview.html	CA	479	1,6,7,12 B,C,D,E
University of California- Irvine School of Medicine, Irvine http://www.meded.uci.edu/curricular-affairs/first-year-curriculum.asp	CA	484	1,4,6,8,12 A,C,D,E
University of California-Riverside School of Medicine, Riverside http://medschool.ucr.edu/mep/mdcurriculum.html	CA	234	1,7,13 B,E i
University of California - San Diego School of Medicine, San Diego https://meded.ucsd.edu/index.cfm//ugme/curriculum_requirements//curriculum_overview/	CA	579	1,6 A,B,J ii
University of California -San Francisco School of Medicine, San Francisco https://meded.ucsf.edu/bridges-curriculum	CA	791	1,5 B,E,G,J ii
UC Berkeley/UCSF Joint Program http://sph.berkeley.edu/jmp/curriculum **there wasn't a listing for enrollment for this school on AAMC website as it might be	CA	N/A	I Learner-led PBL classroom curriculum;

considered part of University of California-San Francisco			Students receive concurrent Master's in Health and Medical Sciences
University of Colorado School of Medicine, Aurora http://www.ucdenver.edu/academics/colleges/medicalschool/education/degree_programs/MDProgram/Pages/default.aspx	CO	802	1,6,8,12 B,E,H
Frank Netter School of Medicine at Quinnipiac University, New Haven https://www.qu.edu/schools/medicine/programs/md-program.html	CT	362	1,12 B,E i
University of Connecticut School of Medicine, Farmington https://medicaleducation.uconn.edu/curriculum/m-d-curriculum/	CT	441	1,2,6,12 C,E,G,J ii First two years are focused on TBL patient-centered and case-based
Yale School of Medicine, New Haven http://medicine.yale.edu/education/curriculum	CT	565	1,6,8 C,E ii
Georgetown University School of Medicine, District of Columbia https://som.georgetown.edu/som.georgetown.edu/curriculum/foundationalphase	DC	814	B,C,E,J ii
The George Washington University School of Medicine and Health Sciences, District of Columbia http://smhs.gwu.edu/academics/md-program/curriculum	DC	726	1,11 A,B,E,G ii
Howard University School of Medicine, District of Columbia https://medicine.howard.edu/education/medical-doctor-md-program	DC	503	1,5 B,C,E
Charles E. Schmidt College of Medicine at Florida Atlantic University, Boca Raton http://med.fau.edu/ume/index.php	FL	260	1,6,8,11,12 C,J i
Florida International University Herbert Wertheim College of Medicine, Miami https://medicine.fiu.edu/academics/degrees-	FL	499	1,3,7,12 A,B,C,H

and-programs/doctor-of-medicine/curriculum/index.html			
The Florida State University College of Medicine, Tallahassee, Daytona Beach, Fort Pierce, Orlando, Pensacola, Sarasota http://med.fsu.edu/index.cfm?page=medicalEducation.home	FL	482	Tallahassee main campus: 1,14 B,J ii Other campuses only for 3rd and 4th years
University of Central Florida College of Medicine, Orlando https://med.ucf.edu/academics/md-program/integrated-curriculum/	FL	492	1,6,7,8,11,12 A,B,C,E i
University of Florida College of Medicine, Gainesville, Jacksonville http://education.med.ufl.edu/medical-students/curriculum/	FL	597	Gainesville campus: 1,6,11,12 B,C,G Jacksonville just has 3rd and 4th years there
University of Miami Leonard M. Miller School of Medicine, Miami http://admissions.med.miami.edu/md-programs/general-md/curriculum	FL	853	1,6,9,11,12,13 A,B,C,E
University of South Florida Health Morsani College of Medicine, Tampa http://www.health.usf.edu/medicine/mdprogram/eduprograms	FL	717	1,8 A,B,J
Emory University School of Medicine, Atlanta https://med.emory.edu/education/programs/md/curriculum/4phases/index.html	GA	644	1,3,6 A,C,E,H,I 5 month Discovery program allows time for clinical or bench research, international experience, or other academic inquiry.
Medical College of Georgia at Augusta University, Augusta, Athens, Albany, Rome, Savannah/Brunswick http://catalog.augusta.edu/preview_program.php?catoid=28&poid=4094&returnto=3432	GA	960	Augusta campus: 1,8,10 A,B,E,G Athens campus:

			1, 6,7,8,10 B,G Other campuses are for 3rd and 4th years
Mercer University School of Medicine, Macon, Savannah, Columbus, and Atlanta https://medicine.mercer.edu/academics/	GA	462	Macon and Savannah campuses: 1,11,12 B,E,I,J ii Accelerated track for primary care doctors that can be completed in 3 years; Full Problem-based learning curriculum Atlanta and Columbus campuses are for 3rd and 4th year only
Morehouse School of Medicine, Atlanta http://www.msm.edu/Education/mdProgram/curriculum.php	GA	370	1, 10,11 A,C,E
John A. Burns School of Medicine University of Hawaii at Manoa, Honolulu http://jabsom.hawaii.edu/ed-programs/md-program/md-curriculum/md-curriculum-overview	HI	282	B,E,I 6 of 8 instructional units organized around problem-based learning (PBL) tutorials
University of Iowa Roy J. and Lucille A. Carver College of Medicine, Iowa City https://medicine.uiowa.edu/md/teaching-and-learning/curriculum/new-horizons-md-curriculum	IA	678	1,6 C,J
Chicago Medical School at Rosalind Franklin University of Medicine and	IL	795	1,6 B,C,E,G ii

Science https://www.rosalindfranklin.edu/academics/chicago-medical-school/degree-programs/allopathic-medicine-md/curriculum/			
Loyola University Chicago Stritch School of Medicine http://ssom.luc.edu/media/stritchschoolofmedicine/centralcurricularauthority/documents/CurriculumMap2016_2017.pdf	IL	675	A,C
Northwestern University Feinberg School of Medicine, Chicago http://www.feinberg.northwestern.edu/education/curriculum/model/index.html	IL	760	1,11,12 A,C,E,G
Rush Medical College of Rush University Medical Center, Chicago https://www.rushu.rush.edu/rush-medical-college/doctor-medicine-md-program/md-program-curriculum	IL	544	1,6,7,12,13 A,B,C,E,I ii Flipped Classroom Approach
Southern Illinois University School of Medicine, Springfield http://www.siumed.edu/oec/html/curriculum.htm	IL	297	1,12 B,E
University of Chicago Division of the Biological Sciences, The Pritzker School of Medicine http://pritzker.uchicago.edu/page/md-curriculum	IL	417	1,11 C,D ii
University of Illinois College of Medicine, Chicago, Peoria, Rockford http://chicago.medicine.uic.edu/education/m_d_curriculum	IL	1389	Chicago campus: 1,6,10,11,13 D Other campuses are for 3rd and 4th years
Indiana University School of Medicine, Bloomington, Evansville, Fort Wayne, Indianapolis, Muncie, Northwest (Gary), South Bend, Terre Haute, West Lafayette https://medicine.iu.edu/education/md/curriculum/	IN	1459	All campuses: 1,6,11 B,C,G ii
University of Kansas School of Medicine, Kansas City, Wichita, Salina http://www.kumc.edu/school-of-medicine/education/ace-curriculum.html	KS	876	Main campus Kansas City, but other campuses follow same

			curriculum: 1,3,6,8,12 A,B,E,I,J ii Case-based curriculum with one big case each week with smaller subsidiary cases
University of Kentucky College of Medicine, Lexington and Morehead http://meded.med.uky.edu/curriculum-overview	KY	566	Main campus in Lexington: 1,6,8,11,12,13 A,B,E Morehead campus only for 3rd and 4th years
University of Louisville School of Medicine, Louisville http://louisville.edu/medicine/ume/curriculum/curriculum-overview	KY	654	1,5 B,C,I,J ii eQuality is LQBT-focused medical curriculum http://louisville.edu/medicine/ume/curriculum/equality
Louisiana State University Health Sciences Center School of Medicine in New Orleans http://www.medschool.lsuhsc.edu/medical_education/undergraduate/spm/curriculum.aspx	LA	826	1,2,6,9,10,11 A,B,D,E ii
Louisiana State University School of Medicine in Shreveport http://www.lsuhscshreveport.edu/Education/som/academicaffairs/students/index%20(2)	LA	507	1,14 A
Tulane University School of Medicine, New Orleans https://medicine.tulane.edu/education/md-program/curriculum	LA	788	B,C
Boston University School of Medicine, Boston https://www.bumc.bu.edu/busm/admissions/curriculum/	MA	767	1,3,6,7,9,11,12 A,C
Harvard Medical School, Boston	MA	852	1,6,7,9,11,13 A,C,E,J

https://hms.harvard.edu/departments/medical-education/md-programs/pathways			ii
Tufts University School of Medicine, Boston https://medicine.tufts.edu/education/doctor-medicine/curriculum-overview https://medicine.tufts.edu/education/MD-maine-track	MA	872	1,7,8,11,12 A,B,C,E,I Has a track for students in rural medicine in Maine (same curriculum all years)
University of Massachusetts Medical School, Worchester https://www.umassmed.edu/globalassets/office-of-undergraduate-medical-education-media/documents/fom1-brief-course-descriptions.pdf	MA	627	1,7,8,9,10,11,12 A,C,E,G,J
Johns Hopkins University School of Medicine, Baltimore http://www.hopkinsmedicine.org/som/curriculum/genes_to_society/index.html	MD	599	1,6,12,13 A,C,E,J
Uniformed Services University of the Health Sciences F. Edward Hebert School of Medicine, Bethesda https://www.usuhs.edu/curriculum	MD	688	1,6 A,C,E,I,J ii Curriculum focuses primarily on military medicine
University of Maryland School of Medicine, Baltimore http://www.medschool.umaryland.edu/OME/Curriculum/Preclinical-Curriculum/	MD	674	1,2,3,7,11,12 C,E
Central Michigan University College of Medicine, Mount Pleasant https://www.cmich.edu/colleges/cmed/Education/MDProgram/OME/Pages/Curriculum.aspx	MI	408	1,2,7,8 A,B,E i
Michigan State University College of Human Medicine, East Lansing and Grand Rapids, and Flint http://curriculum.chm.msu.edu/index.php	MI	815	All campuses share same curriculum: 1,6,12 G,I,J Chief Complaints and Concerns curriculum (C3)
Oakland University William Beaumont School of Medicine, Rochester https://www.oakland.edu/medicine/curriculum/about/	MI	477	1,2,6,7,9 A,B,C i

University of Michigan Medical School, Ann Arbor https://medicine.umich.edu/medschool/education/md-program/curriculum/curriculum-highlights	MI	784	1,6,9,12 A,B,G,I 3 branches within third phase of M3/M4 curriculum: specialized study, research, travel, starting a company, etc.
Wayne State University School of Medicine, Detroit https://admissions.med.wayne.edu/pdfs/year_1_curriculum_revision_map_final_public_with_unit_descriptions.pdf	MI	1242	1,6,8,11,12 A,D
Western Michigan University Homer Stryker M.D. School of Medicine Kalamazoo http://med.wmich.edu/MD-curriculum	MI	267	1,6,12 A,B,C,F i
Mayo Clinic School of Medicine, Rochester, MN; Scottsdale, AZ; and Jacksonville, FL http://www.mayo.edu/mayo-clinic-school-of-medicine/programs/md/curriculum	MN	294	Same curriculum for Rochester and Scottsdale: 1,6,11,12 A,B,C,E,I,J Science of Health Care and Delivery Curriculum: students learn how health care system work; done throughout all 4 years + the regular medical curriculum, and students receive a certificate upon completion. http://www.mayo.edu/mayo-clinic-school-of-medicine/programs/md/curriculum/science-of-health-care-delivery Jacksonville is only 3rd and 4th year

University of Minnesota Medical School, Minneapolis, Duluth https://www.med.umn.edu/admissions/curriculum	MN	996	Both campuses have same curriculum: 1,6,7,9 A,C,D
St. Louis University School of Medicine, St. Louis https://www.slu.edu/medicine/medical-education/md/curriculum/curriculum-by-year.php	MO	744	A,B,D,H
University of Missouri-Columbia School of Medicine, Columbia, and Springfield https://medicine.missouri.edu/education/medical-education-curriculum/first-year-second-year	MO	445	Columbia main campus: 1,6,7,12,14 C,E,I Basic Science/Patient-based learning (BSci/PBL) curriculum Springfield campus for 3rd and 4th years
University of Missouri-Kansas City School of Medicine, Kansas City http://med.umkc.edu/md/curriculum/	MO	459	C,D,I 3 different tracks that students can follow
Washington University in St. Louis School of Medicine, St. Louis https://mdadmissions.wustl.edu/education/customizing-your-education/	MO	629	1,6,12 B,D
University of Mississippi School of Medicine, Jackson https://www.umc.edu/som/Students/Current%20Students/Curriculum/M1%20-%20First%20Year.html	MS	603	1,3,7,11 B,D
The Brody School of Medicine at East Carolina University, Greenville http://www.ecu.edu/cs-dhs/bsomadmissions/curriculum.cfm	NC	327	1,6 D
Duke University School of Medicine, Durham https://medschool.duke.edu/education/student-services/office-curricular-affairs	NC	546	1,6,7,11,12 A,C,I,J Complete core clerkships in 2nd year, leaving 3rd year for scholarly

			investigation; completing a dual degree; many first-year classes are doing flipped classroom approach
University of North Carolina School of Medicine, Chapel Hill https://www.med.unc.edu/md/curriculum/tec-curriculum-information	NC	835	1,6,8,9,11 A,B,E,G,J ii
Wake Forest School of Medicine of Wake Forest Baptist Medical Center, Winston Salem http://www.wakehealth.edu/School/MD-Program/Our-Curriculum.htm	NC	519	1,6,8,12,14 A,C,E
University of North Dakota School of Medicine and Health Sciences, Grand Forks, Bismarck, Fargo, and Minot https://med.und.edu/education-resources/medical-education.html	ND	306	Grand Forks main campus: A,C,E Other campuses 3rd/4th year
Creighton University School of Medicine, Omaha, NE and Phoenix http://catalog.creighton.edu/medicine/curriculum/	AZ	629	Omaha campus: 1,12 A,B,D,H Phoenix campus is 3rd and 4th years only
University of Nebraska College of Medicine, Omaha https://www.unmc.edu/com/curriculum/index.html	NE	540	1,6,7,10,12 A,B,E,G,J ii
Geisel School of Medicine at Dartmouth, Hanover http://geiselmed.dartmouth.edu/ed_programs/mdprog/	NH	409	B,D
Cooper Medical School of Rowan University, Camden http://www.rowan.edu/coopermed/education/meded/overview.php	NJ	344	1,6,12 B,C,F i
Rutgers New Jersey Medical School, Newark http://njms.rutgers.edu/education/index.cfm	NJ	756	1,6,7,8,9,12,14 A,B,E,G,J ii
Rutgers Robert Wood Johnson Medical School, Piscataway & New Brunswick	NJ	717	Both campuses share same

https://rwjms.rutgers.edu/education/medical_education/curriculum/pre-clinical			curriculum: 1,9,11,12 A,C,E
University of New Mexico School of Medicine, Albuquerque http://som.unm.edu/education/md/ume/curriculum-map.html	NM	447	1,6,10,11,13 A,B,E,G
University of Nevada- Las Vegas School of Medicine, Las Vegas https://www.unlv.edu/medicine/curriculum	NV	60	1,8,12 B,G,I i EMT certification in Year 1 of the program
University of Nevada-Reno School of Medicine, Reno http://med.unr.edu/ome/curriculum	NV	285	1,6,9,12 A,B,E
Albany Medical College, Albany http://www.amc.edu/academic/undergraduate/Curriculum.cfm	NY	606	1,6,13 A,B,E
Albert Einstein College of Medicine at Yeshiva University, The Bronx http://www.einstein.yu.edu/education/md-program/curriculum/	NY	825	1,11,12 A,B
City University of New York (CUNY) School of Medicine, Harlem https://www.ccny.cuny.edu/csom/medical-school-curriculum	NY	139	B,I i European-model = students begin the program out of high school, earn a BS and continue on another 4 years for the medical degree
Columbia University College of Physicians and Surgeons, Manhattan, and Cooperstown http://ps.columbia.edu/education/academics/medical-school-curriculum	NY	731	Manhattan: 1,12 C,G Cooperstown only 3rd and 4th years
Donald and Barbara Zucker School of Medicine at Hofstra/Northwell Hempstead http://medicine.hofstra.edu/education/md/index.html	NY	411	1,6,8,12,13 C,F,I PEARLS (Patient-Centered Explorations in

			Active Reasoning, Learning, and Synthesis) are hybrid PBL/TBL cases introduced at the beginning of each week.
Icahn School of Medicine at Mount Sinai, Manhattan http://icahn.mssm.edu/education/medical/program	NY	660	1,7,8,12 A,B,D
Jacobs School of Medicine and Biomedical Sciences at the University at Buffalo, Buffalo https://medicine.buffalo.edu/education/md/curriculum.html	NY	657	1,9,10,11,12,13 A,B,C,E
New York Medical College, Valhalla https://www.nymc.edu/school-of-medicine-som/som-academics/undergraduate-medical-education-md-program/curriculum/	NY	875	1,7 A,D,E
New York University School of Medicine, Manhattan https://med.nyu.edu/education/md-degree/md-curriculum/	NY	604	1,11,12 A,B,E,H,I,J There is an option for an accelerated 3 year MD pathway.
State University of New York Downstate (SUNY Downstate) Medical Center College of Medicine, Brooklyn http://www.downstate.edu/curriculum-renewal/index.html	NY	843	1,6,8,11,12 A,C,E,G,J ii
State University of New York Upstate (SUNY Upstate) Medical University College of Medicine Syracuse http://www.upstate.edu/com/curriculum/index.php	NY	669	1,6,12 A,B,E,D,J ii
Stony Brook University School of Medicine, Stony Brook https://medicine.stonybrookmedicine.edu/ugme/education/MD	NY	579	1,6,7,9,11,12 A,C,E,G,J ii
University of Rochester School of Medicine and Dentistry, Rochester https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/education/md/documents/dhc.pdf	NY	467	1,6,7,10,12 C,E,J

Weill Cornell Medicine Manhattan https://medicaleducation.weill.cornell.edu/medical-education/md-program/curriculum-glance	NY	513	1,7,12 A,C,E ii
Boonshoft School of Medicine Wright State University, Dayton http://medicine.wright.edu/student-life/curriculum	OH	459	1,8,12 A,C,E,G,I,J ii WrightQ are modified PBL sessions which integrate biomedical and clinical science
Case Western Reserve University School of Medicine, Cleveland http://casemed.case.edu/curriculum/education	OH	979	1,8,12 A,C,E,F,J
Cleveland Clinic College of Medicine, Cleveland http://portals.clevelandclinic.org/lcm2/Academics/Curriculum/tabid/7349/Default.aspx *there wasn't a listing for enrollment for this school on AAMC website as it might be considered part of Case Western	OH	N/A	1,6,11,12 A,B,E,I 5 year curriculum which includes a research component which begins the first-year of the program
Northeast Ohio Medical University College of Medicine, Rootstown http://www.neomed.edu/medicine/academics/curriculum/	OH	621	1,8 B,C
The Ohio State University College of Medicine, Columbus https://medicine.osu.edu/students/lsi_curriculum/pages/index.aspx	OH	842	1,6,8,11,12 A,E,G,J
University of Cincinnati College of Medicine, Cincinnati http://med.uc.edu/ome/curriculum/firstyear	OH	722	1,6,8,9,10,11,12 A,C,E
The University of Toledo College of Medicine and Life Sciences, Toledo http://www.utoledo.edu/med/md/curriculum/\	OH	721	1,6,11,12 C,D,E

University of Oklahoma College of Medicine, Oklahoma City https://www.oumedicine.com/college-of-medicine/information-about/college-catalog/medical-school-curriculum	OK	668	1,7,9,12 A,B,C,E,I Two tracks offered: regular academic track and school of community medicine track
Oregon Health & Science University School of Medicine, Portland http://www.ohsu.edu/xd/education/schools/school-of-medicine/about/strategic-initiatives/md-curriculum-transformation.cfm	OR	641	1,6,12 C,E,I,J ii Flipped classroom approach
Drexel University College of Medicine, Philadelphia http://www.drexel.edu/medicine/Academics/MD-Program/Curriculum/	PA	1081	1,6,11 A,C,E,G,J ii
Geisinger Commonwealth School of Medicine Scranton, Danville, Sayre, and Wilkes-Barre https://www.geisinger.edu/education/academics/md-program	PA	439	Scranton main campus: 1,6,8,11,12 A,C i Other campuses are for 3rd and 4th years
Lewis Katz School of Medicine at Temple University, Philadelphia, Bethlehem, and Pittsburgh https://medicine.temple.edu/education/md-program/curriculum	PA	882	Same curriculum at Philadelphia and Bethlehem campuses: 1,10,12 A,B,C,E 3rd and 4th year Pittsburgh campus
Pennsylvania State University College of Medicine, Hershey, and University Park https://students.med.psu.edu/md-curriculum/hershey/ https://students.med.psu.edu/md-curriculum/university-park/	PA	647	Hershey campus: 1,7,9,11,12,14 A,B,D,E,H,I Accelerated 3 year Family Medicine Medical Degree plus 3 year residency –

			University Park Campus: 1,14 C,E,H,I 7 yr program with Thomas Jefferson med school
The Raymond and Ruth Perelman School of Medicine at the University of Pennsylvania, Philadelphia http://www.med.upenn.edu/admissions/module-1.html	PA	778	1,6 A,C,E,I, No phases but called modules; 6 modules throughout four years of medical program;
Sidney Kimmel Medical College at Thomas Jefferson University Philadelphia http://www.jefferson.edu/university/skmc/about/jeffmd.html	PA	1144	1,6,12 B,E,G,I,J, ii 7 year BS/MD program in partnership with Penn State medical school
University of Pittsburgh School of Medicine, Pittsburgh http://www.omed.pitt.edu/curriculum/	PA	661	1,4,6,8,9,10,11,12 A,B,C,D,E
The Warren Alpert Medical School of Brown University Providence https://www.brown.edu/academics/medical/education/md-curriculum	RI	586	1,7,11,12 A,C,I Option for Combined MD/MS in Population Science. The program is the first of its kind in the US
Medical University of South Carolina (MU South Carolina) College of Medicine, Charleston https://education.musc.edu/colleges/medicine/education/medical-students/curriculum/preclerkship	SC	743	1,6,12 A,B,C,E

University of South Carolina School of Medicine, Columbia and Florence http://bulletin.med.sc.edu/content.php?catoid=64&navoid=1785	SC	390	Columbia campus: 1,3,6 A,D Florence campus only for 3rd and 4th years
University of South Carolina School of Medicine Greenville http://bulletin.med.sc.edu/content.php?catoid=64&navoid=1792 http://sc.edu/study/colleges_schools/medicine_greenville/curriculum/index.php	SC	387	1,6,12,14 A,B,C,E,I i Students receive EMT training in their first-year
University of South Dakota Sanford School of Medicine, Vermillion, Sioux Falls, Yankton, and Rapid City http://www.usd.edu/medicine/office-of-medical-education/three-pillar-schedule	SD	274	Vermillion campus: 1,8,11 B,E,G Other campuses are for 3rd and 4th years and ambulatory care program
East Tennessee State University James H. Quillen College of Medicine, Johnson City http://www.etsu.edu/com/acadaffairs/studentinfo/education/mdcurriculum.php	TN	283	1,12 C,D
Meharry Medical College School of Medicine, Nashville http://www.mmc.edu/education/som/aboutus/index.html	TN	475	1,6
University of Tennessee Health Science Center College of Medicine, Memphis, Chattanooga, Nashville, and Knoxville http://www.uthsc.edu/Medicine/OLSEN/index.php	TN	694	Memphis is main campus: 1,6,7,12 B,C Other campuses 3rd/4th years
Vanderbilt University School of Medicine, Nashville https://medschool.vanderbilt.edu/ume/academic-program/md-curriculum/	TN	437	1,6,8,10,14 G,J ii
Baylor College of Medicine, Houston https://www.bcm.edu/education/schools/medical-school/md-program/curriculum	TX	827	1,6,7,11,12 B,D,E

Joe R. and Theresa Lozano Long School of Medicine, University of Texas Health Science Center at San Antonio, San Antonio http://som.uthscsa.edu/UME/curriculum.asp	TX	886	1,3,6 B,C,E,J
McGovern Medical School at the University of Texas Health Science Center at Houston https://med.uth.edu/oep/medical-education/curriculum/	TX	1011	1,5 B,C ii
Paul L. Foster School of Medicine Texas Tech University Health Sciences Center, El Paso http://elpaso.ttuhsc.edu/som/catalog/ContentOverview.aspx	TX	420	1,6,7,12,14 A,C,E i
Texas A&M University Health Science Center College of Medicine, Bryan-College Station, Dallas, Houston, Round Rock, and Temple https://medicine.tamhsc.edu/degrees/md.html	TX	784	Bryan/College Station campus =A&M Integrated Medicine curriculum= a 3rd year integrated clerkship 1,8 I Other campuses are for 3rd and 4th years
Texas Tech University Health Sciences Center School of Medicine, Lubbock, Amarillo, and Odessa http://www.ttuhsc.edu/medicine/academic-affairs/curriculum/overview.aspx	TX	738	Lubbock is main campus: 1,6,7,11,12,14 A,C,E,I 3 year accelerated track for Family Medicine program Other two campuses are for 3rd and 4th years only
The University of Texas at Austin	TX	100	1,7,8,10,11,12,14 C,H,I,J

Dell Medical School, Austin https://dellmed.utexas.edu/curriculum			i Students begin clerkships in their 2nd yr, and 3rd yr is for students to engage in research or complete a dual degree
University of Texas Medical Branch at Galveston School of Medicine, Galveston https://som.utmb.edu/som-educational-affairs/instructional-management-office/curriculum-information-overview	TX	971	1,9,12,13,14 A,B,C,E,J
University of Texas Rio Grande Valley School of Medicine, Edinburg https://www.utrgv.edu/school-of-medicine/academics/curriculum/index.htm	TX	103	1,6,11 B,C i
University of Texas Southwestern Medical Center at Dallas, Southwestern Medical School, Dallas http://www.utsouthwestern.edu/education/medical-school/academics/curriculum/	TX	991	1,6,9,11,12,13 B,D,E
University of Utah School of Medicine, Salt Lake City http://medicine.utah.edu/students/programs/md/curriculum/	UT	503	1,6,7,8,11,12,14 C,E,H
Eastern Virginia Medical School, Norfolk https://www.evms.edu/education/medical_programs/doctor_of_medicine/careforward_curriculum/	VA	607	1,6,9,14 A,B,C,E,I,J ii 4 year ultrasound curriculum
University of Virginia School of Medicine, Charlottesville https://med.virginia.edu/ume-curriculum/curriculum/	VA	667	1,6,10,12 A,J ii
Virginia Commonwealth University School of Medicine, Medical College of Virginia Health Sciences Division, Richmond and Falls Church https://medschool.vcu.edu/education/md-program/	VA	920	Richmond main campus: 1,9,11,13 A,C,H Falls Church only for 3rd and 4th years

Virginia Tech Carillion School of Medicine and Research Institute, Roanoke https://medicine.vtc.vt.edu/academics/phase1.html	VA	168	1,6,8,10,11,12 A,C,E,F i
The Robert Larner, M.D. College of Medicine at the University of Vermont, Burlington http://www.med.uvm.edu/mededucation/curriculum	VT	476	1,6,8,9,11,12 A,B,C,G,J ii
University of Washington School of Medicine, Seattle, WA and other locations in Bozeman, MT; Anchorage, AK; Moscow, ID; and Laramie, WY https://www.uwmedicine.org/education/md-program/current-students/curriculum/phase-1-foundations	WA	1124	Each medical school campus follows the same curriculum: 1,3,6,7,10,12 C,E,G,I,J ii
Washington State University Elson S. Floyd College of Medicine, Spokane https://medicine.wsu.edu/md-program/curriculum/community-based-medical-education/	WA	60	1,6,8 B,C,D,I i Community-based model of education with students only from state of Washington
Medical College of Wisconsin, Milwaukee, Green Bay, and Wausau http://www.mcw.edu/Medical-School/Discovery-Curriculum.htm	WI	983	1,7,8,12 A,B,C,D,E,I,J Accelerated 3 year option for Green Bay and Wausau campuses
University of Wisconsin School of Medicine and Public Health, Madison http://www.med.wisc.edu/md-program-forward-curriculum/48018	WI	761	1,6,8,11,12,13,14 C,E,G,J ii
Marshall University Joan C. Edwards School of Medicine, Huntington https://jcesom.marshall.edu/media/56634/curriculum-at-a-glance.pdf	WV	312	C
West Virginia University School of Medicine, Morgantown, Martinsburg, and Charleston http://medicine.hsc.wvu.edu/md-admissions/curriculum/	WV	449	Morgantown main campus: 1,6,8,9,11,12 C

			Charleston and Martinsburg campus for 3rd and 4th year only

Key for type of curriculum, per school's website

1. Integration, any way
2. Vertical integration
3. Horizontal and vertical integration (both terms used together)
4. Horizontal/longitudinal integration
5. Integration alone (e.g., "integrated curriculum" with no other descriptive factors)
6. Integration of basic and clinical sciences
7. Integration of courses
8. Integration of (longitudinal) clerkships
9. Integration of organ systems
10. Integration of learning modes (e.g., integration of PBL, TBL, small group learning, dissection, etc.)
11. Integration of disciplines
12. Integration of concepts
13. Integration of normal and disease (abnormal, pathology) state
14. Integration other

A. Organ systems approach or based description
B. Full or most systems courses (e.g., courses listed as Cardiovascular system, Respiratory system, GI system)
C. Topic courses (e.g., Human Structure, Fundamentals of the Human Body)
D. Discipline courses (e.g., Anatomy, Physiology, Microbiology)
E. Use the term block/module/unit
F. 2 phases of curriculum
G. 3 phases of curriculum
H. 4 phases of curriculum
I. Other type of curriculum (plus description of curriculum in the box)

J. Named curriculum

ii. New medical school in last 10 years

ii. Only new medical curriculum in last 10 years

Appendix B

Medical School Faculty Survey

The purpose of this study is to examine the different types of medical school curricula at medical schools throughout the United States. This includes how the curriculum is set up, how long it has been implemented, and what is included in it, focusing on the anatomical sciences. The purpose is also to investigate the perceptions of faculty members about their schools' curricula. Some responses of schools which have undergone curricular reform will be compared with responses from schools which have not undergone reform, but the main goal of the survey is to examine any revised curriculum of the medical school. This survey will be transferred into a Qualtrics or SurveyMonkey online survey, with the link being given out to interested participants.

Dear Respondent,
My name is Melissa Taylor, and I am a PhD student at Indiana University, studying Anatomy Education. Thank you for taking the time to fill out this survey. This survey will take about 15 minutes to complete and will ask you questions pertaining to the curriculum that your medical school follows. It is my hope to receive responses from medical schools that have both undergone or not undergone curricular reform. The benefit to you is that you will contribute to a larger understanding of curricular reform and possibly influence the change in curricular reform at other schools. I will be using these responses as part of my dissertation entitled, *Medical Education Reform and its Impact on the Teaching and Learning of the Anatomical Sciences*. I will protect the confidentiality of the answers given in this survey, and respondents' participation is completely voluntary.
You can contact me (Melissa Taylor) if you have any questions about the survey.

<u>Survey</u>

1. At which university medical school are you located?
   Name of School____
   Location (city, state) ________________________________

2. Has your medical school undergone any major curricular reform in the last 10 years (e.g., having stand-alone courses combined into one course; vertically integrating material into different years of medical school; incorporating team-based or problem-based learning into the majority of the curriculum)?
   - Yes
   - No

3. If you answered yes, you may describe what the major curricular reform entailed below.

4. How long ago was the curricular reform implemented?
   - Less than one year ago
   - 1 to 5 years ago
   - 6 to 10 years ago

- Don't know

5. After the implementation of the major curricular reform, have there been any additional substantial revisions (e.g., reduction of lecture hours, revision of course goals, standardization of exams, or addition or elimination of courses) to the reform of this program?
    - Yes
    - No
    - Don't know

6. Please briefly explain what the substantial revisions were.

7. Please give an example of 1 or 2 classes that have been changed due to the curricular reform and how they are changed from the previous curriculum? Additionally, if you have a visual representation of what your curriculum looks like, such as a layout of what courses are taught when during the year, please email me at taylomel@iupui.edu

8. What were the reasons for the curricular reform? Please select all that apply.
    - LCME review
    - Administration review
    - Student dissatisfaction with past curriculum
    - Faculty dissatisfaction with past curriculum
    - Being proactive about LCME accreditation standards (preparing for re-accreditation)
    - Keeping up with current trend of curricular reform
    - Other (please explain)___________________________

9. For approximately how long did preparation take for your school's curricular reform (from initial planning phase to implementation phase)?
    - Less than one year
    - 1-2 years
    - 2-3 years
    - 3-4 years
    - 4-5 years
    - More than 5 years
    - Don't know
10. Did you actively participate in the initial development process of the curricular reform?
    - Yes
    - No

11. To what extent was your curricular reform faculty versus administration driven?
    a. 1 (entirely faculty driven)
    b. 2
    c. 3 (equal faculty and administration driven)

d. 4
e. 5 (entirely administration driven, no faculty input)

If your medical school has non-integrated curricula:

12. Is your medical school planning to undergo any major curricular reform in the next 10 years?
    a. Yes
    b. No
    c. Don't know

For integrated curriculum:

13. Do you teach Gross Anatomy at your medical school?
    - o Yes
    - o No
14. How is the subject of Gross Anatomy offered in your school's curriculum?
    - o Stand-alone course
    - o Part of a systems-based course
    - o Combined with another discipline (e.g., with microscopic anatomy)
    - o Other: Please explain___________________________

15. What types of pedagogical methods are used in the course where Gross Anatomy is taught?
    - o Traditional lectures
    - o TBL
    - o PBL
    - o Flipped classroom experience
    - o Pre-recorded lectures
    - o Discussion groups
    - o Case-based study
    - o Other, please explain______________________
16. Approximately what percentage of the lecture course time in which Gross Anatomy topics are taught is dedicated to the following pedagogical methods? Total must add up to 100
    - o Traditional lectures___________
    - o TBL___________
    - o PBL_____________
    - o Flipped classroom experience__________
    - o Pre-recorded lectures___________
    - o Discussion groups________
    - o Case-based study_________
    - o Other_______

17. Is there a Gross Anatomy lab experience which is a required component of this curriculum (either separate or combined with another lab)?
    - o Yes

- No

18. Which of the following are currently used in the Gross anatomy lab experience? Select all that apply.
    - Student-led dissection of cadavers
    - Student-led dissection of animals (e.g., cats)
    - Teacher-led demonstrations on prosections (previously dissected cadavers)
    - Peer teaching
    - Team-based or problem-based learning
    - 2D printed images from an atlas or textbook (e.g., Thieme Atlas)
    - Computerized modules (e.g., online cadaver demonstration such as AnatomyPal or Anatomy and Physiology Revealed)
    - 3D computer models of anatomical structures (e.g., Anatomage Table)
    - Anatomy- in-clay models
    - Virtual microscopic slides
    - Optical microscopic slides
    - Bones
    - Models
    - Medical imaging (e.g., CTs, MRIs, X-rays)
    - Interactive ultrasound demonstrations
    - Other (please describe):___________________________________
    - Don't know
19. To what extent has the Gross anatomy LECTURE experience changed since your school had undergone curricular reform?
    - 1 = Not at all
    - 2 = To a small extent
    - 3 = To some extent
    - 4 = To a moderate extent
    - 5 = To a large extent
20. To what extent has the Gross anatomy LAB experience changed since your school had undergone curricular reform?
    - 1 = Not at all
    - 2 = To a small extent
    - 3 = To some extent
    - 4 = To a moderate extent
    - 5 = To a large extent

21. Please say a few words about how specifically the lecture and/or lab experience has changed since your school has undergone curricular reform.

22. Has the amount of time of instruction related to Gross anatomy topics increased, decreased, or stayed the same since your school has undergone curricular reform?
    - Increased
    - Decreased
    - Stayed the same
23. Has the number of topics related to Gross anatomy increased, decreased, or stayed the same since your school has undergone curricular reform?

- Increased
- Decreased
- Stayed the same

24. Are their additional opportunities (e.g., electives) that revisit material related to gross anatomy in the third or fourth year of the medical program at your school?
    - Yes
    - No
25. Do you teach Microscopic Anatomy at your medical school?
    - Yes
    - No
26. How is the subject of Microscopic Anatomy offered in your school's curriculum?
    - Stand-alone course
    - Part of a systems-based course
    - Combined with another discipline (e.g., with gross anatomy)
    - Other Please explain____________________________
27. What types of pedagogical methods are used in the course where Microscopic Anatomy is taught?
    - Traditional lectures
    - TBL
    - PBL
    - Flipped classroom experience
    - Pre-recorded lectures
    - Discussion groups
    - Case-based study
    - Other, please explain______________________
28. Approximately what percentage of the lecture course time in which Microscopic Anatomy topics are taught is dedicated to the following pedagogical methods? Total must add up to 100
    - Traditional lectures___________
    - TBL___________
    - PBL_____________
    - Flipped classroom experience__________
    - Pre-recorded lectures___________
    - Discussion groups________
    - Case-based study_________
    - Other_______

29. Is there a Microscopic anatomy lab experience which is a required component of this curriculum (either separate or combined with another lab)?
    - Yes
    - No
30. Which of the following are currently used in the Microscopic anatomy lab experience? Select all that apply.
    - Virtual microscopic slides
    - Optical microscopic slides
    - Peer teaching

- Team-based or problem-based learning
- 2D images from text books
- Other (please describe):___________________________________
- Don't know

31. To what extent has the Microscopic anatomy LECTURE experience changed since your school had undergone curricular reform?
    - 1 = Not at all
    - 2 = To a small extent
    - 3 = To some extent
    - 4 = To a moderate extent
    - 5 = To a large extent
32. To what extent has the Microscopic anatomy LAB experience changed since your school had undergone curricular reform?
    - 1 = Not at all
    - 2 = To a small extent
    - 3 = To some extent
    - 4 = To a moderate extent
    - 5 = To a large extent

33. Please say a few words about how specifically the lecture and/or lab experience has changed since your school has undergone curricular reform.
34. Has the amount of time of instruction related to Microscopic anatomy topics increased, decreased, or stayed the same since your school has undergone curricular reform?
    - Increased
    - Decreased
    - Stayed the same
35. Has the number of topics related to Microscopic anatomy increased, decreased, or stayed the same since your school has undergone curricular reform?
    - Increased
    - Decreased
    - Stayed the same

36. Are their additional opportunities (e.g., electives) that revisit material related to Microscopic anatomy in the third or fourth year of the medical program at your school?
    - Yes
    - No
37. Do you teach Neuroanatomy at your medical school?
    - Yes
    - No
38. How is the subject of Neuroanatomy offered in your school's curriculum?
    - Stand-alone course
    - Part of a systems-based course
    - Combined with another discipline (e.g., with microscopic anatomy)

- Other   Please explain___________________________

39. What types of pedagogical methods are used in the course where Neuroanatomy is taught?
    - Traditional lectures
    - TBL
    - PBL
    - Flipped classroom experience
    - Pre-recorded lectures
    - Discussion groups
    - Case-based study
    - Other, please explain______________________
40. Approximately what percentage of the lecture course time in which Neuroanatomy topics are taught is dedicated to the following pedagogical methods? Total must add up to 100
    - Traditional lectures___________
    - TBL___________
    - PBL_____________
    - Flipped classroom experience__________
    - Pre-recorded lectures___________
    - Discussion groups________
    - Case-based study_________
    - Other_______
41. Is there a Neuroanatomy lab experience which is a required component of this curriculum (either separate or combined with another lab)?
    - Yes
    - No
42. Which of the following are currently used in the Neuroanatomy lab experience? Select all that apply.
    - Student-led dissection of cadavers
    - Student-led dissection of animals (e.g., cats)
    - Teacher-led demonstrations on prosections (previously dissected cadavers)
    - Peer teaching
    - Team-based or problem-based learning
    - Preserved cross sections of brains
    - 2D images from an atlas or text book
    - Computerized modules (e.g., online cadaver demonstration such as AnatomyPal or Anatomy and Physiology Revealed)
    - 3D computer models of anatomical structures (e.g., Anatomage Table)
    - Anatomy- in-clay models
    - Virtual microscopic slides
    - Optical microscopic slides
    - Bones
    - Models
    - Medical imaging (e.g., CTs, MRIs, X-rays)
    - Other (please describe):___________________________________
    - Don’t know

43. To what extent has the Neuroanatomy LECTURE experience changed since your school had undergone curricular reform?
    - 1 = Not at all
    - 2 = To a small extent
    - 3 = To some extent
    - 4 = To a moderate extent
    - 5 = To a large extent
44. To what extent has the Neuroanatomy LAB experience changed since your school had undergone curricular reform?
    - 1 = Not at all
    - 2 = To a small extent
    - 3 = To some extent
    - 4 = To a moderate extent
    - 5 = To a large extent
45. Please say a few words about how specifically the lecture and/or lab experience has changed since your school has undergone curricular reform.
46. Has the amount of time of instruction related to neuroanatomy topics increased, decreased, or stayed the same since your school has undergone curricular reform?
    - Increased
    - Decreased
    - Stayed the same
47. Has the number of topics related to Neuroanatomy increased, decreased, or stayed the same since your school has undergone curricular reform?
    - Increased
    - Decreased
    - Stayed the same
48. Are their additional opportunities (e.g., electives) that revisit material related to Neuroanatomy in the third or fourth year of the medical program at your school?
    - Yes
    - No

<u>Integrated Program and Non-integrated program</u>

49. To what extent do you agree or disagree with the following statements?
    a. I am enjoying teaching within our school's curriculum.
        - Strongly agree
        - Agree
        - Neutral
        - Disagree
        - Strongly disagree

       Please explain:
    b. I feel my students are getting adequate knowledge of gross anatomy with our school's curriculum.
        - Strongly agree
        - Agree
        - Neutral
        - Disagree

- Strongly disagree

Please explain

c. I feel my students are getting adequate knowledge of microscopic anatomy with our school's curriculum.
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

    Please explain

d. I feel my students are getting adequate knowledge of neuroanatomy with our school's curriculum.
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

    Please explain

e. I feel like this medical program is producing adequately-trained medical doctors.
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

    Please explain

Integrated and Non-integrated

50. Overall, how pleased are you with your school's curriculum? (1 = not at all pleased and 10 = extremely pleased)
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10
51. Please comment on some things that you like about your school's curriculum.
52. Please comment on some things that you do not like about your school's curriculum.

53. Do you have any constructive suggestions for how to improve your school's curriculum?

Integrated only

54. Would you be willing to participate in a brief phone interview to expand upon your perceptions of curricular reform at your school in the future? This phone call will last about 30 minutes and can be scheduled at your convenience.
    - Yes
    - No

If you answered yes,
Contact info
Name:
Phone number I could reach you at (please indicate work or cell):
Preferred time of day to call:
Email address

Appendix C

Interview Questions for Medical School Faculty

The purpose of this interview is to investigate medical school faculty instructors' attitudes and beliefs regarding curricular reform at their institution. This interview is voluntary and anonymous, and will be conducted either in person, via telephone, or via Skype. Participants can opt into this interview by checking a box on the previous survey and providing their contact information. This interview will serve as a more in-depth look at questions they had already answered on the survey – so interview questions may change depending on their responses to the survey.

1. Can you please state your name for me and your institution at which you work?
    a. What is your role at this institution? (I will already know this from the survey; I would just want the participant to relay it to me in the interview).
    b. How long have you been at this medical school?
2. What led to the need for curricular reform at your school?
    a. Did you actively participate in the initial development process of curricular reform and in what way?
    b. How has the medical school changed in the years that you have been there? – This can be related directly to the reform or related to something else.
3. How has your course changed as a result of the curricular reform?
    a. Is it combined with another course? If so, what is the name of that course?
    b. How to you feel about the amount of time devoted to teaching (insert their subject here)?
    c. Have there been significant revisions to the content of your course since the curricular reform? – Number of topics decreased, number of contact hours decreased, lab time decreased, etc?
    d. What topics and/or activities have been changed or taken out completely with the reform?
4. Overall, how do you feel about the curriculum at your school?
5. How do you think your students are doing now as a result of the curriculum, specifically the reform the school has undergone?
    a. Have there been any significant changes that you have seen, such as increase in exam scores or in STEP scores?
    b. Do you know what the students' attitudes are towards the school's curriculum?
    c. What do you think is an accurate way to measure the success of a medical program?
6. What do you think the point of curricular reform is?
7. Is your school planning to undergo any more curricular reform in the near future – or to revise the current curriculum?
    a. If so, what is the school planning to do?

Appendix D

Indiana University School of Medicine-Bloomington First-year Medical Student Survey

The purpose of this study is to examine the views of first-year medical students enrolled at the IU School of Medicine-Bloomington campus about the new curriculum which was implemented this year. This will include questions asking about their overall perceptions of the new curriculum as well as their perceptions on the courses which teach the anatomical sciences such as gross anatomy, histology, and neuroscience.

Dear Respondent,
My name is Melissa Taylor, and I am a PhD student at Indiana University, studying Anatomy Education. Thank you for taking the time to fill out this survey. This survey will take about 15 minutes to complete and will ask you questions pertaining to the curriculum that your medical school follows. The benefit to you is that you will contribute to a larger understanding of curricular reform and possibly influence the change in curricular reform at other schools. I will be using these responses as part of my dissertation entitled, "The Role of Anatomical Sciences in Medical Education Reform". I will protect the confidentiality of the answers given in this survey, and respondents' participation is completely voluntary.
You can contact me (Melissa Taylor) if you have any questions about the survey.

1. When you were interviewed for this medical program, were you told that the Indiana University School of Medicine would be implementing a new curriculum this school year?
   - O Yes
   - O No

   For the next few questions, a scale of 1-5 will be used with 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree.
   You also have the option to explain your answer choice below each question.
2. For each of the below anatomical science topics, please indicate how satisfied you felt with the amount of time dedicated to teaching those topics in your first year of medical school.

   a. Gross Anatomy
      - o Very dissatisfied
      - o Dissatisfied
      - o Neutral
      - o Satisfied
      - o Very satisfied

   b. Microscopic Anatomy
      - o Very dissatisfied
      - o Dissatisfied
      - o Neutral
      - o Satisfied

- Very satisfied

c. Neuroanatomy
   - Very dissatisfied
   - Dissatisfied
   - Neutral
   - Satisfied
   - Very satisfied

3. Please explain any of your answer choices to the above question.
4. For each of the below anatomical science topics, please indicate the degree to which how rushed you felt with having to learn the information for your block exams.

a. Gross Anatomy
   - Very rushed
   - Rushed
   - Neutral
   - Not very rushed
   - Not at all rushed

b. Microscopic Anatomy
   - Very rushed
   - Rushed
   - Neutral
   - Not very rushed
   - Not at all rushed

c. Neuroanatomy
   - Very rushed
   - Rushed
   - Neutral
   - Not very rushed
   - Not at all rushed

5. Please explain any of your answer choices to the above question

6. I like how gross anatomy and histology were integrated (combined) into the Human Structure course, as opposed to having separate courses for each subject.
   - Strongly disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly agree
   - Please explain your answer choice.

7. For each of the below anatomical science topics, please indicate the degree to which you agree with the following statement: I believe the IUSM curriculum prepared me enough for my NBME subject examinations for the below subject

topics. Please think of Gross Anatomy and Microscopic Anatomy as separate topics, even though they are integrated into the same NBME exam.

a. Gross Anatomy
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree
b. Microscopic Anatomy
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree
c. Neuroanatomy
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree

8. Please explain any of your answer choices to the above question.
9. Overall, how pleased are you with your school's curriculum? (1 = not at all pleased and 10 = extremely pleased)
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10
10. Please comment on some things that you like about the IUSM curriculum.
11. Please comment on some things that you do not like about the IUSM curriculum
12. Do you have any constructive suggestions for how to improve the school's curriculum?

Appendix E

Focus Group Questions for First-year Medical Students at Indiana University School of Medicine-Bloomington

The purpose of this focus group is to investigate first-year medical students' attitudes and beliefs regarding curricular reform at their institution. This focus group is voluntary and anonymous, and will not affect course scores. The focus group will be conducted in person. This interview will serve as a more in-depth look at questions you may have already answered on the survey – so interview questions may change depending on their responses to the survey.

The following are general questions that may be addressed during the interview, though the order and specific questions asked will be based on the natural flow of conversation.

1. When you interviewed for this program, what were you told about the medical curriculum, if anything?
2. How do you feel about the number of course hours devoted to the anatomical sciences in this program (gross anatomy, histology and neuroscience)? What about their placement within the curriculum (e.g., integrated into another course, stand-alone course)? For example, the microscopy part of histology is integrated with gross anatomy in Human Structure, while Neuroscience is a stand-alone course. How do you feel about these courses?
3. Would you prefer these courses to be taught all separately or do you enjoy having some of them lumped together?
4. Are there any subjects in any of the classes you have taken where you have found there was not adequate time to cover it all? If so what kinds of classes and which subjects?
5. How has the teaching of the material in your classes gone - such as having different instructors during the semester for different topics?
6. How have the exams been? Do you feel adequately prepared for your NBME exams?
7. With this curriculum, do you think you are being adequately prepared to be a medical doctor?
8. Is there anything you would like to see changed in this curriculum?
9. Are there any other comments on the curriculum that you would like to say?

Appendix F

Focus Group Questions for IUSM-Bloomington Anatomical Sciences Faculty

The purpose of this focus group is to investigate the attitudes and beliefs of faculty of the anatomical sciences (gross anatomy, histology, and neuroanatomy) at the IU School of Medicine-Bloomington campus, regarding curricular reform at their institution. This focus group is voluntary and anonymous. The focus group will be conducted in person. This interview will serve as a more in-depth look at questions which may have already been answered on the faculty survey – so interview questions may change depending on responses to the survey.

The following are general questions that may be addressed during the interview, though the order and specific questions asked will be based on the natural flow of conversation.

1. What led to the need for curricular reform at IUSM-Bloomington?
    a. When and how did the process begin?
    b. Did the timeline for completion of the reform change throughout the process?
2. How has the Human Structure course developed? What was the initial thought to combine Gross Anatomy and Histology topics into one class?
    a. What has it been like interacting with other professors from different disciplines and campuses to develop and teach the course?
        i. What are some of the advantages of teaching an integrated course that you have seen?
        ii. What are some of the disadvantages with the course itself?
        iii. What are some advantages/disadvantages of the interdisciplinary collaboration?
    b. How to you feel about the compressed time to teach the topics that are covered in Human Structure?
    c. What things do you want to revise for the course when you teach it next year? For example: incorporating more ultrasound demos, introducing more clinical information to the topics, have more or less peer teaching in gross lab, etc.
    d. Do you know of any specific things that will be changing for the Human Structure course for Fall of 2017?
3. How do you think your students are doing now as a result of the curricular revision?
    a. Have there been any significant changes that you have seen, such as increase in exam scores or NBME scores? – Obviously with the integrated course it is hard to directly compare past exams with exams from this year, but are there topics or units that students seem to be understanding better with teaching an integrated class?
    b. Do you know what the students' attitudes are towards the school's curriculum?
4. Is there anything else you would like to say about curricular reform at your school?

Appendix G

Codebook for Faculty Survey

Codes and Sub codes	How term used for this research	Select text examples
Integration of Organ Systems	Courses combined by organ systems, e.g., cardiovascular, gastrointestinal, etc.	Stand-alone discipline courses were replaced with systems-based, integrated coursework in the preclinical years
Integration of Courses	Combination of distinct courses or disciplines	Discipline based courses retained in year 1 but more added and some other combined into an interdisciplinary molecules to cells course.
Clinical Integration	Combination of foundational science material with clinically-oriented material	Integration of the basic sciences with clinical correlations…
Vertical Integration	Integration across time, such as from one year to the next in medical school	From a standard, course-block based curriculum in 2013 we changed to a vertically integrated curriculum
Horizontal Integration	Integration across disciplines or content, for a set period of time	Horizontal integration of basic sciences in first-year curriculum into basic principles and organ system modules
Spiral Integration	Combination of vertical and horizontal integration	integration of anatomy into several of the blocks both horizontally and vertically
Clinical Integration	Integration of clinical content in pre-clerkship years	introducing clinical aspects earlier
Shortened pre-clerkship curriculum	Describe how pre-clerkship curriculum has been reduced from the normal 2 year time frame	Transition to 18-month systems-based curriculum
Reduction in Contact hours	Describe how there is less time devoted to teaching an anatomical subject. Does not have to say "contact hours" but has to make reference to how there is less face to face time	No lectures; all material is online. Gross anatomy lab reduced to about 77 hours, with only half of each group in lab at any time
Reduction of didactic lectures	Describe how lectures are being reduced in number	With fewer hours allotted to lecture, many lectures have been compressed or lightened in content.

		Lab is now more hours per day and more days per week.
Reduction of Content	Describe how material is being reduced from courses	…and the basic science content was distributed across a series of courses called "Mechanisms of Health and Disease."
Active Learning	Strategies to teach material other than didactic lectures	We do case-based learning in small groups; computer exercises are beneficial.
Team-based learning (TBL)	Say this	Introduction of team based learning into our patient centered learning integrated curriculum.
Problem-based learning (PBL)	Say this	we went from a traditional lecture based program to PBL
Case-based	Say this	change to more case based, small group
Flipped classes	Say this	combining courses, emphasizing flipped classrooms
Technology	Describe how technology is used in the classroom. While may not be strictly active learning, it is not fully didactic learning	Newer technologies for lecture, addition of new imaging modalities in lab
Non-didactic learning lab	Describe lab component of course. While lab is not strictly didactic like a lecture but not quite fully part of active learning like TBL, it has its own distinction	Lab component of the musculoskeletal block is now completely taught through pre-dissected cadavers to ensure that we are able to cover all musculoskeletal content in only 6 labs.
Reduction of dissections	Specific to gross anatomy lab, describe how cadaver dissections are reduced in number or in depth of coverage	Lab time has been reduced and requires a very active prosection and team-driven experience to complete as needed.
Virtual Microscopy	Describe how virtual microscopy is used with teaching microscopic anatomy	Change from exclusively microscope based, to a hybrid, to exclusively virtual microscopy
Reduction of faculty-guided labs	Describe how face to face labs in microscopic anatomy were reduced	Lab has gone from being an in-class session to almost entirely self-directed modules students complete on their own time.
New Medical Curriculum	Describe how their medical school is new or currently undergoing curricular change	We are a new medical school based on a system based curriculum with PBL. Anatomy is integrated into each system block.

Compression of Courses	Describe how courses are being reduced into small chunks of time	neuroscience was compacted from a 4 month course to a 6 week block
Dispersal of Content	Describe how content related to a subject being spread across more than one course	Gross Anatomy and Neuroanatomy have been broken up from stand-alone classes to components of organ-based blocks.
Reversal of Curriculum	Describe how medical curriculum began doing something one way but then backtracked and changed it to how it was originally done	all gross anatomy lectures and labs were stopped out, but it did not work and we re-introduced both lectures and full body dissection. this was a very difficult process since re-introduction required a substantial effort both in terms of resources and faculty re-engagement.
Like Organization of Curriculum	Describe how faculty like the way in which their curriculum is organized	The integration of anatomy with physiology and other disciplines within organ system courses is effective. The integration of ultrasound into anatomy is good.
Like Integration	Describe how faculty like the way in which aspects of their curriculum is combined together	An integrated, organ system approach is a better way to teach medical students than traditional discipline-based courses as it is more aligned with how they will use the information in their clinical careers.
Like Clinical Exposure	Describe how faculty like that students have exposure to clinical information and to patients	Students seem to be happy with the early exposure to clinical experiences and with the integration that comes with the systems-based curriculum. I like it that our anatomy course is almost the only course that our students are taking at that time, so students are focusing on anatomy.
Like Content	Describe how faculty like overall content taught in courses; does not have to be specific about what content entails	Organized, learning objective driven, active learning incorporated to a reasonable extent, multiple modalities of content delivery
Like Systems	Describe how faculty like organ systems-based teaching of material	Anatomy, histology, and embryology are taught during a first semester anatomy course. Later in the systems-based courses, these

		disciplines are revisited and there is more emphasis on that system and clinical integration.
Student-centered	Describe curriculum focused on student interests	(100% pass rate on Step 2-CS). The small, student-centered culture at the medical school is a rewarding environment for educators and students. Not just a hospital with a med school attached.
Like Outcomes	Describe how faculty like student assessment outcomes that show how curriculum works for them	…and our medical students score well on the neuroanatomy and anatomy USMLE shelf exams and Step 1 in the anatomical sciences
Like Support	Describe how faculty like a supportive environment in their curriculum	Extremely friendly atmosphere for learning All faculty seem open and willing to help any student Excellent camaraderie and friendly working relationship among all faculty
Interdisciplinary	Describe how faculty like that they interact with faculty from other disciplines	In the process of designing this curriculum, faculty from all campuses have been communicating much more. I actually feel like I've got a broader support system within the institution. Consistency between campuses is also nice. It was so varied in the old curriculum, and I think a more consistent design is more fair to students.
Dedicated Faculty	Faculty are dedicated to teaching in their curriculum	We have many dedicated instructional faculty. This makes a big difference for students, for the integrity and smooth running of a course, and allows us to provide a superior student experience in their first year.
Receptive Administration	Administration is willing to listen to faculty about what is and is not working for the curriculum	There is strong centralized support from the college (staff, resources, etc.). Students are encouraged to diversify and individualize during medical school.
Content Concerns	Describe how faculty have concerns about what students are being taught in their courses	elimination of free standing embryology and cell and tissue biology course have reduced emphasis on these topics. lost the

		interplay between the embryology and clinical anatomy course
Worrisome Outcomes	Describe worry from faculty about how students will fare on examinations and once they are done with school	The pass-fail grading coupled with the very low passing standard has greatly undermined the students' incentive to study.
More Resources	Describe need for more resources to deliver content	we need a more stream lined dissector that is easier for students, more prosections, more explicit integration of basic science and physical exam, more faculty development of clinical faculty on the basic science connections
Issues with faculty involvement	Describe how faculty feel they are not as involved in curriculum as they would like to be OR that they were too involved in the curriculum, with little other time for teaching and scholarship	Basic science faculty were limited in their contribution to the curriculum design.
Contribution	Describe issues with levels of faculty contribution to the curriculum	I don't feel the course directors at our school are treated well in that they deal with a lot of headaches and problems, and they do not receive the proper compensation or benefits for their hard work. Being a course director should be more valued in a medical school curricula, especially when your students usually score in the top quartile in standardized exams.
Administrative Reach	Describe how faculty feel like administration is controlling curriculum	Lack of communication about impending changes from the administration; Extremely slow response from administration on faculty support or requests for additional faculty
Add Content	Describe how improvement to curriculum should be to add content back in	I would increase the overall length of the anatomy course. Alternatively, I would add in refresher courses (maybe of focused topics within anatomy) later in the curriculum.
Delivery	Describe how information should be delivered in curriculum	Add more active-learning sessions. . .we received by students and quantum knowledge gain!

Innovation	Describe how medical school should look for innovative solutions to revise curriculum	Encourage more innovation on a course-by-course basis. The college seems most interested in sweeping, curriculum-wide initiatives. Innovative faculty who improve their own courses are less visible and their ideas don't get shared very easily.
Encourage Involvement	Describe how faculty want administration to encourage their involvement in design of curriculum	For it to be successful, the impetus for reform will need to come from the teaching faculty, and not from administrators playing the "LCME card".
Communication	Describe how communication between faculty and administration	communication between administrative issues on curriculum reform and changes in the calendar needs improvement
Evaluation	Describe how curriculum is or should be evaluated	Increase the standard for passing
Focused Outcomes	Describe how assessment and outcomes of curriculum should be clearly outlined	In the future, I think the focus on the medical school curricula will be to prepare students to do well on the Board Exams…
Student Feedback	Describe how students should be listened to for their feedback about the curriculum	At this point, we just need to really look at what our students are learning and take their feedback seriously. We need to be willing to make some changes after this first rollout year.

Appendix H

Codebook for Faculty Interview

Codes	Definition	Select text examples
Administration-driven	Describe as curricular reform enacted by administration	every curricular reform came from top-down, came from the dean of curriculum we were just given the guidelines.
Competition with other medical schools	Describe as medical school undergoing curricular reform to keep up with current trend of other medical schools undergoing reform	Leadership saw that we were falling behind the national trend of switching to a systems-based program and they though it would help the students be more successful on the national boards
LCME	Describe as curricular reform driven by LCME accreditation standards/future site visit for reaccreditation	an upcoming LCME accreditation this year triggered much of the changes
Constant Change	Medical schools undergoing continuous change in their curricula	it's been one curricular reform after another. And they only run about every 10 years. People feel the need to change.
Reversal	Describe how medical curriculum began doing something one way but then backtracked and changed it to how it was originally done	We have gone through three different curricular reforms, and they have gone basically through one mode of teaching to another and then back.
Indifference	Describe as feelings of indifference about curriculum; may want change but don't want to put in the effort to enact change	So I don't really like the curriculum we have here but I'm not willing to devote the time and energy to switch it
Uncertainty	Feeling unsure of how curriculum will work in favor of students	So that's the one thing that worries me and something that's probably not unique to UCSF is sometimes the faculty don't really get to voice their opinions on what they think should be changed or reassessed or improved upon.
Integration	Combining things together in curriculum	So now it's integrated with what is called Human Structure. Basically, the major part is anatomy and then it integrated the basics of radiology and then embryology.
Non-didactic learning	Anything done in the course other than face to face lecture	I think the hallmark of our new curriculum, that we like most, that

		institutions are moving to more active learning. This I think it's probably been the most radical change we have significantly reduced the amount of lecture time, increasing the number of small group activities.
Self-regulated learning	Students studying on their own with slight assistance from faculty; not self-directed learning which is where students make own learning objectives. They may do a little of that for these descriptions, but primary aspect is self-regulated learning	The faculty encourage students to look things up and engage in discussion with their colleagues.
Efficiency	Describe curriculum as working in a well-organized manner	We basically have 12 weeks of instruction but it's spread out over 17 weeks. It is a course that's retained. I think much of what was done previously but we've actually streamlined and removed content that we feel students don't need those types of detail in their first pass
Interdisciplinary	Describe as working with other individuals from different disciplines	But when we progress into the other topics, where I don't have much of the expertise, then we have people from neurology, oncology, pathology who are involved in teaching components of the course.
Shortened Pre-clerkship curriculum	Describe how pre-clerkship curriculum has been reduced from the normal 2 year time frame	So it used to be 2 years of pre-clerkship and then the Step 1 exam. And then it changed to 18 months pre-clerkship.
Reduced contact hours	Describe how there is less time devoted to teaching an anatomical subject. Does not have to say "contact hours" but has to make reference to how there is less face to face time	Well first of all, we lost close to 40% of our course time. It went from 157 hours down to 96.

Compensation (decreased detail)	Describe as topics not decreased in curricula with reduced time but detail on topics is reduced; some aspects of discipline not emphasized as much as others	For example so we did the face, they don't dissect all the branches of the facial nerve any more, they just prosect one or two of that.
Board Scores	Describe as student outcome measures on their licensing examinations	I think we have a lot of people on pins and needles waiting to see how they will do on Step 1, just curious to see if it changes. My expectation is that it's not going to be any different than previous years. You know if they have made it to this point already, then typically they are pretty capable of doing well. I think they are going to be ok. I don't expect any significant changes on Step 1
Student Evaluations	Describe as evaluations completed by students about faculty and medical curriculum	It's another to basically structure everything we do around feedback. The students are not the experts
Knowledge retention	Describe as hopeful goal of curriculum for students to retain medical knowledge as they progress in their careers	So our job is to make the curriculum as interesting and stimulating to the students as possible to make them help them learn and retain it well.
Critical thinking skills	Describe as hopeful goal of curriculum for students to be able to think critically when confronted with a problem in their professional careers	And part of empirical based reasoning maybe has nothing to do with setting a broken bone or doing some sort of diagnostic, but it's medical reasoning. It's looking at facts and accumulating knowledge and synthesizing it to be able to achieve some sort of conclusion from that.
Professionalism	Describe as hopeful goal of curriculum for students to be able to learn the professional skills of a physician in the medical curriculum	We also have something where they go out with a physician and work with them one afternoon a month for the entire first two years. And that allows them to get a first-hand experience taking history and things like that. I think all those things were really good positives of curriculum reform.

Realism	Describe as realistic reactions to curriculum; not optimistic and not pessimistic but accepting the situation for what it is	So I think there's been some good things about curricular reform. We have gone to a system where the kids see a lot more relevant what they are doing sooner. When they are going through the first two years, they are able to see the why a little bit quicker. Also then, with the curriculum reform, part of that, not only has the basic sciences been remodeled. But we have made room in the afternoon, so they can have earlier clinical experiences. We had some exposure to that in the old curriculum, but now even more so with the new curriculum. … I think all those things were really good positives of curriculum reform. Part of me is a little bit cynical to some degree. I mean, you know, a lot of the changes that we make are forced on use by the LCME in terms of active learning and not lecturing as much. I don't know if there is a ton of evidence for that. I think they want us to change just to change. For the most part, that I mentioned before, have been positives. They are good things

Appendix I

Codebook for Student Survey

Codes	Definition	Select text examples
Curricular organization	Describe how curriculum is organized overall, including various descriptions of the anatomical science courses in the IUSM curriculum	For gross anatomy, I wish that there had been more time allotted to go over structures/findings with the professor in the lab. As far as histology, this was a particularly challenging subject for those who had never seen the subject before and I wish we would have had more ways to go over the different slides/images. For neuroanatomy, I felt that there was a little too much time dedicated to the anatomy portion of the course.
Student Performance	Describe grades on examinations	Neuroscience was insane. No student should have to go through that, and certainly the fact that the average class score on the first exam was below last year's pass cut off of 70%
Rigor	Describe curriculum standards as rigorous and tough to attain	Anatomy and histology (neuro included) at IUSM feel very rigorous, and thorough-ness is important to me to feel satisfied with a course
Reduced Time	Describe reduction of time in curriculum, not particular to course hours or content, just overall reduction in time devoted to teaching a course	Although I was satisfied with the gross anatomy course, I would have liked to have a full year as in the legacy course. In regard to histology I was not satisfied with the limited amount of true lecture time.
Content Delivery	Describe how information is given to students in curriculum in regard to integration format	I like the idea of it, but histology has proven to be very important to future pathology and physiology study and felt underrepresented in human structure.
Lack of Comparison	Describe how students cannot compare an aspect of the medical curriculum they are currently experience because they have no prior experience with any other way	I don’t really have an idea of what it would have been like to have the curriculum as separate classes.

Lack of Preparation for NBME exams	Describe how students did not feel prepared enough for their NBME exams	Need more NBME style practice questions
Self-regulated learning	Students studying on their own with slight assistance from faculty; not self-directed learning which is where students make own learning objectives. They may do a little of that for these descriptions, but primary aspect is self-regulated learning	Histology was the luck of the draw. Since we had to teach ourselves the images and what to look for, we had no way of knowing if what we were learning was correct.
Like Grading System	Describe how students liked the pass/fail grading system at IUSM	I like the pass-fail aspect, which takes a lot off of the students' shoulders
Active Learning	Strategies to teach material other than didactic lectures	I like doing case based problems when they reinforce topics we've already studied.
Standardization	Describe how campuses at IUSM all have same curriculum	I do like that the curriculum between campuses are meant to be more equal at this point
Faculty Support	Describe how students like a supportive environment in the curriculum	I like how the staff at the Bloomington campus are really in favor of the students. They really seem to identify with what we need.
Increase Time	Describe how students want more time dedicated to teaching courses in the curriculum	Neuroanatomy in the first two weeks was extremely aggressive, much of the most important information was thrown at us
Reevaluate how material is presented	Desire for faculty to look at how material is organized and present it in a meaningful manner	Give more time for Neuroscience. Consider separating it from Psychiatry. Also, make anatomy a year long course (you could also then include neuroanatomy and neuroscience in the anatomy course)!
Communication	Describe communication among students, faculty and administration	I would like to see more interaction between the Medical Student Council and the Curriculum Steering Committee
Interprofessional skills	Describe how students want to be taught professionalism skills	For interprofessional skills, give us more challenging problems to work on that will demonstrate communication skills.

Appendix J

Codebook for Student Focus Group

Codes	Definition	Select text examples
Disconnectedness	Describe how students felt like what they were told and what actually happened in curriculum was different	Even with the human structure, there was somewhat of a disconnect between what we were told to know and what showed up on the exam.
Communication	Describe communication among students, faculty and administration	I think, a lot of the rest of the courses they did that in, there wasn't communication with others, so they would talk about something and not explain it, so it was, like, they were trying to get the best people on the topic to teach it, but sometimes it wasn't communicated well across the board what we have been taught and what we had not.
Frustration	Describe how students feel upset and annoyed at various aspects of the curriculum	would like it on record to that the 9 or 10 times they said we are not going to be guinea pigs, that they were lying to us.
Confusion	Describe how students feel a lack of understanding about various aspects of the curriculum	It's very much they are planning out the courses as they are happening, and I don't know why they haven't been planned out the year before.
Optimism	Describe how students feel hopeful and confident about the future of the curriculum	I actually feel like this is gonna work, that we just need to get all the bugs out of it.
Team-based learning (TBL)	Use those words	I think part of it is that if the TBLs were used to practice material we learned, that would be effective
Integration	Combining concepts together	Yeah, I really liked the integration in theory than in practice. A lot of times it seemed disjointed. I
NBME	Discuss their board and subject examinations	I always though the NBME question-wise was way more straight-forward.
Clinical Experience	Describe having clinical experience in curriculum, such as being able to visit with patients	We get clinical exposure really early on. I don't think it's that common.

Appendix K

Codebook for Faculty Focus Group

Codes	Definition	Select text examples
LCME	Describe as curricular reform driven by LCME accreditation standards	I think the easy answer is the LCME. But, um, let's be honest. The curriculum was not changed since the 1970s
Standardize Campuses	Describe as curricular reform driven by need to align IUSM campuses together with same curriculum	all of the centers need to demonstrate comparable learning activities which initially felt very much like exactly identical activities. Very difficult to do if you're at a small center with 14 students and a larger center with 150.
Constant Change	Medical schools undergoing continuous change in their curricula	One of the administrators at IU school of medicine mentioned to me from conversation that she heard that when you think curricular revision is done. She said not really. Seems like you have to reinvent the curriculum every single year for the first five years
Faculty Collaboration	Describe as ability for faculty from other campuses to work together on curriculum as also on other aspects of faculty life	They know who you are, right, there is at least people on every campus that knows us which can be beneficial.
Clearer Connections	Describe as integration of material allowing for students to make clearer connections between things they learn	So I think they're getting a better understanding of entire organs from the cell on up.
Reduced Time	Describe reduction of time in curriculum, not particular to course hours or content, just overall reduction in time devoted to teaching a course	all of us have had content and time cut from the courses, and some of that time cut we've been okay with. But there's been other places where I feel we do have an actual deficit that we are not entirely convinced students will gain additional understanding in later courses
Deficit in Student Learning	Describe how students are not learning enough material in curriculum for later use in clerkships/career	But there's been other places where I feel we do have an actual deficit that we are not entirely convinced students will gain additional understanding in later courses.

Grading System	Describe reactions to pass/fail grading system at IUSM	And that's actually my biggest concern with this curriculum is the low pass because we've had passing rates that were so low that I just don't have a lot of confidence in that. Yeah, its two standard deviations
Professionalism	Describe how curriculum prepares students to learn professionalism skills and what it's like to work in a professional environment	And that [peer teaching] will hopefully improve communication skills and presentation skills and there's a lot of benefits to that

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Wilson, A. B., Miller, C. H., Klein, B. A., Taylor, M. A., Goodwin, M., Boyle, E. K., Brown, K., Hoppe, C., & Lazarus, M. 2018. A meta-analysis of anatomy laboratory pedagogies. *Clinical Anatomy*, *31*(1), 122-133.

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CURRICULUM VITAE

Melissa Anne Taylor

EDUCATION:

Date	Degree	Institution
2013-2019	Ph.D., Anatomy and Cell Biology Education Track Dissertation: The Impact of Medical Education Reform on the Teaching and Learning of the Anatomical Sciences	Indiana University Bloomington, IN
2013	M.S., Kinesiology – Exercise Physiology focus Graduate Project: Analysis of a High School Enrichment Opportunity in the Anatomical Sciences	University of Illinois-Chicago Chicago, IL
2011	B.S., Exercise Science, Biology and Psychology Minor	Appalachian State University Boone, NC

PROFESSIONAL ORGANIZATION MEMBERSHIPS:

2013-present American Association of Anatomists (AAA)

2013-present Human Anatomy and Physiology Society (HAPS)

PROFESSIONAL HONORS AND AWARDS:

Date	Award Name	Granted By
2014, 2016, 2017, 2018	AAA Travel Grant ($350)	American Association of Anatomists
2014	HAPS Student Travel Award ($350)	Human Anatomy and Physiology Society
2014	Women in Science and Engineering Travel Grant ($400)	Indiana University Biology Department

PUBLICATIONS:

PEER REVIEWED

1. Wilson, A. B., Brown, K. M., Misch, J., Miller, C. H., Klein, B. A., **Taylor, M. A.,** Goodwin, M., Boyle, E.K., Hoppe, C., & Lazarus, M. D. (2018). Breaking with tradition: A scoping meta-analysis analyzing the effects of student-centered learning and computer-aided instruction on student performance in anatomy. *Anatomical sciences education*.
2. Wilson, A. B., Miller, C. H., Klein, B. A., **Taylor, M. A.,** Goodwin, M., Boyle, E. K., Brown, K. Hoppe, C. & Lazarus, M. (2018). A meta-analysis of anatomy laboratory pedagogies. *Clinical Anatomy*, 31(1), 122-133.
3. Wilson, A. B., **Taylor, M. A**., Klein, B. A., Sugrue, M. K., Whipple, E. C., & Brokaw, J. J. (2016). Meta-analysis and review of learner performance and preference: virtual versus optical microscopy. *Medical education*, *50*(4), 428-440.

BLOG POSTS

1. Taboas, Charity; Reynolds, Amberly; Smith, Theo, and **Taylor, Melissa**. *Undergraduate Teaching Assistant Pedagogy Training Workshop, Part 1*. (2018). Indiana University School of Medicine Blog, Research in Medical Education https://medicine.iu.edu/blogs/research-in-medical-education/uta-pedagogy-training-workshop-part-1/
2. Smith, Theo; Reynolds, Amerberly; **Taylor, Melissa**; and Taboas, Charity. *Undergraduate Teaching Assistant Pedagogy Training Workshop, Part 2*. (2018). Indiana University School of Medicine Blog, Research in Medical Education https://medicine.iu.edu/blogs/research-in-medical-education/undergraduate-teaching-assistant-pedagogy-training-workshop-part-2/

PRESENTATIONS FROM CONFERENCES:

ORAL

Date	Title	Conference
2018	**Taylor, Melissa**; Smith, Theo; Reynolds, Amberly; Taboas, Charity; Husmann, Polly, and O'Loughlin, Valerie. *For the Love of Teaching: Implementing a Graduate Student-Driven Training Program for Undergraduate Teaching Assistants*	Human Anatomy and Physiology Conference (Columbus, OH)
2017	**Taylor, Melissa**. *Improving Learning Skills in Anatomy*	Human Anatomy and Physiology Conference (Salt Lake City, UT)

POSTER

Date	Title	Conference
2018	**Taylor, Melissa**. *A New Curricular Schema for Allopathic Medical Schools in the United States*	Experimental Biology Conference (San Diego, CA)
2018	Brown, Kirsten; Wilson, Adam; Misch, Jonathan; Miller, Corinne; Klein, Barbie; **Taylor, Melissa**; Goodwin, Michael; Boyle, Eve; Hoppe, Chantal, and Lazarus, Michelle. *Breaking with tradition: A scoping meta-analysis analyzing the effects of student-centered and computer aided instruction on student performance in anatomy*	Experimental Biology Conference (San Diego, CA)
2018	Smith, Theo; **Taylor, Melissa;** Reynolds, Amberly; Taboas, Charity; Husmann, Polly, and O'Loughlin, Valerie. *The Effect of Formal Training on Undergraduate Teaching Assistants' Performance and Views Towards Teaching*	Experimental Biology Conference (San Diego, CA)
2017	**Taylor, Melissa.** *Previous Learning Experiences in the Anatomical Sciences*	Experimental Biology Conference (Chicago, IL)
2016	**Taylor, Melissa.** *A Look at Types of Questions asked in Gross Anatomy Lab: An Analysis at Indiana University-Bloomington School of Medicine*, *Part II*	Human Anatomy and Physiology Conference (Atlanta, GA)
2016	**Taylor, Melissa.** *A Look at Types of Questions asked in Gross Anatomy Lab: An Analysis at Indiana University-Bloomington School of Medicine, Part I.*	Experimental Biology Conference (San Diego, CA)
2014	**Taylor, Melissa** and Bareither, Mary Lou. *Analysis of a High School Enrichment Opportunity in the Anatomical Sciences.*	Experimental Biology Conference (San Diego, CA)

INVITED TALKS:

Date	Title	Organization
2015,2016	**Taylor, Melissa.** *The Microscopic Anatomy of the Cardiovascular System*	IU School of Dentistry, first-year dental school lecture

2014	**Taylor, Melissa**. *The Cardiovascular System*	Indiana University School of Medicine – Indianapolis, Anatomy Education Summer Camp for High School Science Educators

MEDIA INTERVIEWS:

1. Anatomy Education Podcast. (2018). Episode #44: Early Career Anatomy Educators http://anatomypodcast.co.uk/episodes/early-career-anatomy-educators/

PROFESSIONAL DEVELOPMENT:

Date	Course/Workshop Title	Provider
2018	Ultrasound Club	Indiana University
2014-2017	Preparing Future Faculty Conference	Center for Innovative Teaching and Learning
2015	M620: Pedagogical Methods in the Health Sciences	Indiana University School of Medicine
2015	An Introduction to Evidence-Based Undergraduate STEM Teaching	CIRTL (Center for Integration of Research, Teaching, and Learning) & Vanderbilt University

TEACHING ASSIGNMENTS:

GRADUATE/MEDICAL LEVEL

2017: **Human Structure (Med-X620), Indiana University**

Title: Lab Associate Instructor
Credit hours: 8
Enrollment: 36 students
Teaching/Responsibilities: This is an integrated course which combines gross anatomy, embryology, and histology. I demonstrated relevant gross anatomy structures on human cadavers, cross sections, models, and medical images. I completed prosections on the material that was to be completed by the students that day to serve as an example. I set up, proctored, and graded lab exams. I assisted students with understanding histological concepts of anatomy. I assisted the students with learning how to operate an ultrasound machine to find the relevant structures they learned in the class. I presented the lecture on the middle mediastinum and the heart.

2015: **Medical Neuroscience (M555), Indiana University**

Title: Lab Associate Instructor

Credit hours: 3
Offered: spring semester
Enrollment: 36 students
Teaching/Responsibilities: I demonstrated relevant structures on brains, models, and medical images. I set up, proctored, and graded lab exams. I served as a preceptor for medical case studies and team-based learning activities.

2013-2014: **Gross Medical Anatomy (MSCI A550/551), Indiana University**
Title: Lab Associate Instructor
Credit hours: 8 total (4 fall and 4 spring)
Offered: starting in the fall
Enrollment: 39 students
Teaching/Responsibilities: I assisted students in their dissections of human cadavers and demonstrated relevant structures on cadavers, models, bones, and medical images (X-ray, MRI , and CT scans). I completed prosections on the material that was to be completed by the students that day to serve as an example. I set up and graded lab exams. I assisted the students with the use of ultrasound to find relevant structures they were discussing in the class.

UNDERGRADUATE LEVEL

2013-2018: **Improving Learning Skills in Anatomy (M100), Indiana University**
Title: Instructor
Credit hours: 1
Offered: every fall and spring semester
Enrollment: 35 students
Teaching/Responsibilities: I created my own syllabus for this class. I created activities that the class would utilize in their anatomy (A215) class that they took concurrently, including practice exams, learning matrices, drawing activities, and concept maps.

2013-2019: **Basic Human Anatomy (ANAT A215), Indiana University**
Title: Lab Associate Instructor
Credit hours: 5 (semester-long class)
Offered: every fall, spring, and summer semester
Enrollment: 450 students in lecture; 40 per lab class
Teaching/Responsibilities: I instructed students in the anatomical terms they needed to know for their exams by demonstrating on models, histological images, and human cadavers. I set up, proctored, and graded their lab exams. I prosected cadavers over the summer that would be used for the next three semesters of the class.

2017-2018: **Human Tissue Biology (A464), Indiana University**
Title: Lab Associate Instructor
Credit hours: 4
Offered: every spring semester
Enrollment: 50 students

Teaching/Responsibilities: I designed this classroom to be a flipped class by creating videos and PowerPoint presentations which demonstrate relevant histology structures for the students to view before class. They would then come to class with any questions about the material and complete check-in activities. I created all lab exam questions and graded exams. I proctored lecture exams. I gave a lecture on the topic of eye and ear.

2012-2013: **Anatomy and Physiology (KN 251/252), University of Illinois-Chicago**
Title: Lab Teaching Assistant
Credit hours: 10 total (5 fall and 5 spring)
Offered: every fall and spring semester
Enrollment: 400 students in lecture; 30 students per lab class
Teaching/Responsibilities: I instructed students in the anatomical terms on models, cadavers, and microscopes that they needed to know for their exams. I set up and graded lab exams. I helped proctor lecture exams.

2011-2012: **Exercise Physiology (KN 352), University of Illinois-Chicago**
Title: Lab Teaching Assistant
Credit hours: 4 (semester-long class)
Offered: every fall, spring, and summer
Enrollment: 100 students per semester
Teaching Responsibilities: I graded quizzes, exams, lab reports, and research projects. I instructed students every week on how to use exercise lab equipment and how to conduct their own research to create a semester-end research project.

EDUCATIONAL OUTREACH AND SERVICE:

Date	Role	Organization
2014-present	Cadaver Presenter	Cadaver demonstrator at Indiana University for high school students
2017	Volunteer for Anatomy Education Research Institute (AERI)	Indiana University-Bloomington
2017	Co-developer and co-leader of A215 undergraduate teaching assistant training program	Indiana University
2017	Moderator of *Navigating The Job Market (Natural Sciences)* session	Indiana University's Preparing Future Faculty Conference through Center for Innovative Teaching and Learning (CITL)
2016	Judge of Indiana Regional Science Fair	Indiana Regional Science Fair for elementary, middle

		and high school students at Marian University
2015-2016	Coach for high school students in Science Olympiad (Anatomy and Physiology)	Bloomington South High School
2014	Cadaver presenter for Anatomy Education Summer Camp for High School Science Educators	Indiana University School of Medicine-Indianapolis
2012-2013	Cadaver Presenter and Leader of Cadaver Enrichment Program	Cadaver demonstrator at University of Illinois-Chicago