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The Effects Of Flipped Learning On Critical Thinking Disposition Among Undergraduate College Students

Mark J. Dusenbury

THE EFFECTS OF FLIPPED LEARNING ON CRITICAL THINKING DISPOSITION AMONG UNDERGRADUATE COLLEGE STUDENTS

by

Mark Joseph Dusenbury
Bachelor of Science, University of North Dakota, 2002
Master of Science, University of North Dakota, 2010

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This dissertation submitted by Mark J. Dusenbury in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

_____
Myrna Olson, Ph.D.

_____
Kathy Smart, Ph.D.

_____
Robert Stupnisky, Ph.D.

_____
Warren Jensen, M.D.

This dissertation is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

_____
Wayne Swisher, Ph.D.
Dean of the School of Graduate Studies

_____
Date

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Title The Effects of Flipped Learning on Critical Thinking Disposition Among Undergraduate College Students

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Mark J. Dusenbury
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ABSTRACT

The purpose of this study was to examine if flipped learning has an effect on students critical thinking disposition, how students' perceptions of flipped learning changed during the semester, and if students in the flipped classroom performed better academically. Participants for this longitudinal, quasi-experimental classroom study included 81 participants, the majority freshman and sophomores at a large Midwestern university, whom registered for an aviation Human Factors course. Two measures in this study examined critical thinking disposition and students' perceptions longitudinally (pretest and posttest) during the 16 week semester. Paired samples *t*-tests, independent samples *t*-tests, and a MANCOVA were used to analyze the data.

A number of findings were found to be nonsignificant; however, the results revealed that the flipped learning significantly increases a student's openmindedness on the California Critical Thinking Disposition Inventory (CCTDI), students in the lecture section had higher overall course satisfaction on the Course Evaluation Survey (CES), and both the lecture and flipped groups rated teaching goals significantly higher on the CES posttest. These findings suggest that students benefited from the increase in peer interactions in the flipped group (increased openmindedness) over the semester, and that faculty have a significant impact on course satisfaction.

CHAPTER I

INTRODUCTION

Located in a small rural community in Colorado is Woodland Park High School. Related to its remote location, student athletes are required to travel to other schools to compete in athletics; the consequence of this requirement is that students miss considerable class time for lengthy travel times. In response, Jonathan Bergmann and Aaron Sams, chemistry teachers at Woodland Park, decided to flip their classrooms. Bergmann and Sams (2014) define flipped learning as "…direct instruction delivered to the individual outside of class, and more strategic use of in-class time for group work and individualized attention" (p. xi). Their impression was that flipped learning was more engaging and that deeper learning occurred, asserting that flipped learning is a viable learning approach.

Woodland Park High School was not the only success story related to flipping the classroom. Clintondale High School, located in Detroit, Michigan, had high failure rates, many discipline issues, and a number of parental complaints. In 2010, the school's principal, Greg Green, decided that drastic change was needed. In 2011, Green flipped all freshman classes, and based on the success, flipped the classes in the entire high school in 2012. The results at Clintondale High School were as follows: failure rates dropped by 30 percent, discipline cases dropped 74 percent, and parental complaints virtually disappeared. Data clearly showed students at Clintondale High School responded to the pedagogical change of flipping the classroom (Green, 2012).

Because of Woodland Park and Clintondale High School successes, flipped learning has gained national attention and is a growing part of the dialogue among educators at all levels. A survey of faculty by the Center for Digital Education and Sonic Foundry revealed that 29 percent are using the flipped classroom model, and 27 percent plan to use it within the next 12 months ("Survey Confirms Growth of the Flipped Classroom," n.d.). Flipping the classroom is changing the national conversation regarding education. The shift from a teacher-centered to a student-centered classroom is underway.

Background

It is important to understand what a flipped classroom is before discussing the broader aspects and implications. The flipped classroom is:

> …a model of learning that rearranges how time is spent both in and out of class to shift ownership of learning from the educators to the students. In the flipped classroom model, valuable class time is devoted to higher cognitive, more active, project-based learning where students work together (*NMC Horizon Report*, 2015, p. 38).

Students arrive for class having watched the recorded lecture and completed the assigned material. During class time, students use their newly acquired knowledge actively, which gives them the opportunity to reinforce and apply the information. The key piece is not the particular activity selected in class; rather, it is that class time is student-centered and active. This broader understanding of learning leads to the two parts of flipped learning.

The Two Parts of Flipped Learning

Flipped learning combines the positive aspects of lecture with the benefits of active learning, which makes flipped learning effective and student-centered. The lecture addresses

factual knowledge, while active learning promotes comprehension and application (Kavous Ardalan, 2008; McKeachie, 1990).

Lecture. Even as calls for more active learning have been recommended (Prince, 2004), studies such as Watts and Schaur's (2011) national survey of economists shows that direct instruction (lecture) remains the dominant method of instructional delivery. They examined four surveys from 1995 to 2005, and noted that direct instruction was the leading form of delivery (i.e., reported 83% of time spent lecturing). A survey conducted by the Mathematics Association of America (MAA) in 2011, found similar results: two-thirds of mathematics instructors still felt students learn best from lectures (Bressoud, 2011). The lecture remains the favorite choice among faculty to deliver instruction in higher education.

The research shows lecture is a good way to transfer facts, yet inadequate when it comes to promoting discussion and deeper thought (Bligh, 1998). The purpose of lectures should be to acquire knowledge and facts, and then apply that knowledge by actively using it in the classroom or lab. It is not a question of whether lecturing is good or bad, but where and how it should be utilized (Burgan, 2006). Flipped learning connects the lecture to active learning, which promotes learning.

Active Learning. Chickering and Gamson (1987) brought active learning to the forefront when they listed active learning as one of the seven principles of good teaching in undergraduate education. A more recent call for active learning was made by The President's Council of Advisors on Science and Technology (PCAST) to engage students and increase retention rates (Olson & Riordan, 2012). The traditional paradigm in higher education has students sitting in large classrooms, listening to, and hopefully assimilating the knowledge and information the lecturer is presenting. Active learning shifts this paradigm by putting the student

at the center of learning, not the instructor. This shift to student-centered learning in higher education makes learning more experiential, which facilitates higher level critical thinking. Active learning places learning in the hands of the students, and the educators become the guides.

Flipped learning connects the acquisition of knowledge and facts through lecture, to active learning in the classroom. Flipped learning is changing the way education is approached, and providing a new way to utilize the time-tested and popular approach to teaching, the lecture.

The Disposition to Think Critically

Research indicates college and universities are doing very little to change students critical thinking over the course of college (Richard & Roksa, 2011), and yet faculty believe critical thinking is the most important skill to develop in their students. In a study published by the Higher Education Research Institute (HERI) at UCLA, over 99 percent of faculty in two surveys given between 2004 and 2008 rated the ability to think critically as "very important" or "essential," the highest ranking of the skills rated (DeAngelo, 2009). Employers feel the same way in that The Association of American Colleges and Universities (AACU) have conducted opinion surveys that indicate higher education needs to improve student's critical thinking ability. In a survey titled "Falling Short? College Student Learning and Career Success," 91 percent of employers surveyed place more importance on the ability to think critically than on the students major. Three-quarters of employers indicated a desire for more emphasis on teaching student's critical thinking, solving complex problems, and communication (American Association of Colleges and Universities, 2015). In a survey titled "Optimistic About the Future, But How Well Prepared? College Students' Views on College Learning and Career Success", the AACU surveyed 613 college students and 400 executives. The survey asked the students and

employers how well college prepared them on 17 different learning outcomes. The majority of the students ranked themselves well prepared in 11 of 17 outcomes, while employers ranked the students lower across all outcomes. For example, 66 percent of students felt they were prepared for critical and analytical thinking; however, only 26% of employers felt they were (American Association of Colleges and Universities, 2015).

There is a disconnect between faculty principles and practices. These surveys demonstrate the importance faculty and employers place on critical thinking, yet results from the Collegiate Learning Assessment (CLA) shows that students only make minimal gains in critical thinking during college. Richard and Roksa (2011) found that students showed only minimal gains from the beginning of their freshman year to the end of their sophomore year. In their study of over 2,300 students, they found that almost half (45 percent) showed no statistically significant gains in critical thinking. Richard and Roksa (2011) summarized the results in this way: "three semesters of college education thus have a barely noticeable impact on students skills in critical thinking, complex reasoning, and writing" (p.35). Faculty need to teach students more than just knowledge and skills in college; faculty must be explicit in improving a student's ability to think critically. In summary, higher education is placing too much emphasis on what to think, rather than how to think. The evidence shows faculty believe critical thinking is essential, and that employers want critical thinkers; however, the data indicates colleges and universities are falling short. College is failing to foster higher level learning in a meaningful way that students can transfer to new contexts. Faculty need to find and use teaching approaches that promote higher student achievement, along with critical thinking disposition.

Statement of Problem

The flipped learning technique is part of a broader educational movement to ensure students today have 21st century skills to compete in the global job market ("NEA - Statement of Principles: 21st Century Skills and the Reauthorization of NCLB/ESEA," n.d.). U.S. education is changing, yet it is struggling to keep pace with the fast-changing world. Entry level jobs require more diverse skills then ever before. Learning and thinking skills are vital in this new global, economy, and:

> As the value of higher education is scrutinized, so, too, is the continued relevance of traditional education models. A disconnect exists today between educators and industry leaders, with little discussion and no agreement on the skill sets that are essential to successful employment. As a result, many students do not acquire the skills necessary for workforce effectiveness and success (King, Marshall, Zaharchuk, & others, 2015).

Educators have to think beyond their classroom and find ways to incorporate and cultivate the skills students will need as they enter the workforce. To do this, educators need to focus on empirically validated teaching practices, that is, pedagogical approaches that build critical thinking skills and dispositions and show higher student achievement than traditional models. Facione (1990) says, "……it is important to consider ways of developing materials, pedagogies, and assessment tools that are effective and equitable in their focus on these affective dispositions (p. 13)". Mastering skills is not enough; students must be disposed to use those skills. Abrami et al. (2008) statement is "…improvement in student's critical thinking skills and dispositions cannot be a matter of implicit expectations (p. 1102)." Higher education must be explicit with the goal of teaching students critical thinking skills and dispositions.

The popularity of the flipped classroom and body of research findings (albeit small and largely anecdotal) gives hope that this pedagogical approach may be a solution. Yet, as Milman (2012) says, "…no empirical research exists to substantiate its use, anecdotal reports by many instructors maintain it can be used at any education level…" (p. 86). This statement suggests that research must empirically validate that flipping the classroom improves student learning, and cultivates the development of critical thinking skills and dispositions. This gap in the literature was the basis for this proposed study.

Statement of Purpose

The purpose of this study was to determine if flipping the classroom changes a student's disposition toward critical thinking. Industry and government are calling for workers who have the skills and disposition to think critically. Traditional education models are failing to produce graduates who have the skills and disposition necessary to be successful in today's workforce.

Research Questions

This study examined the following research questions:

1. Does flipped learning change students critical thinking disposition?
2. Do students' perceptions of flipped learning change during the semester?
3. Do students in a flipped learning course perform better academically than students in a lecture course?

Key Terms

Collaborative Learning: "individuals working as a team for a common purpose or mission (Keser & Özdamli, 2012, p. 157).

Cooperative Learning: "…interaction is characterized by positive goal interdependence with individual accountability (Roger & Johnson, 1988).

Critical Thinking Skills: A set of skills comprised of interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 1990).

Critical Thinking Dispositions: "…the disposition toward critical thinking is the consistent internal motivation to engage problems and make decisions by using thinking (Giancarlo & Facione, 2001)

Flipped Learning: "…a model of learning that rearranges how time is spent both in and out of class to shift ownership of learning from the educators to the students. In the flipped classroom model, valuable class time is devoted to higher cognitive, more active, project-based learning where students work together…(*NMC Horizon Report*, 2015)." This term is commonly referred to in the literature and media as the flipped classroom or inverted learning.

Inverted classroom: name used in some studies in place of flipped classroom.

Assumptions and Delimitations

This study assumes participants made every effort to respond to survey questions completely and truthfully. To promote truthful answers, students' anonymity and confidentiality will be protected. This study is considered voluntary, and students may withdraw at any time.

To help define the boundaries of the study, there are several delimitations. The first is that this study focused on critical thinking disposition, the second is that the naturalistic setting of the classroom was utilized, and the third is that the participants were students in an introductory human factors course in aviation.

There is a large body of research on critical thinking skills, yet there is a small body of research on critical thinking dispositions. Confusion can arise between skills and dispositions and what is specifically being studied. And while this study considered skills, the focus of the research was on critical thinking disposition.

The classroom can be a challenging environment to conduct research. There are a number of factors outside the researcher's control that include but are not limited to: different learning styles, personality type, the day of the week class meets, time of the day class meets, and prior experience with the specific teaching interventions used in the experiment. Every effort was made to control the many variables in the classroom; yet, some, control was not possible due to the natural classroom environment.

The last delimination was that this study is that the participants are aviation students in a human factors course. Generalization outside of this group would be difficult, as the aviation curriculum and this course are very specific. A different course or curriculum may have a different effect on dispositions.

Organization of Study

The layout of this study is designed to give readers the necessary background and framework needed to make sense of the results and discussion. Provided in Chapter II is the conceptual and theoretical framework, a review of flipped learning research, and an examination of critical thinking disposition research. In Chapter III the research design, participants, survey instruments, and procedures are described. The results and analysis of the data to answer the research questions are addressed in Chapter IV. Chapter V is a thoughtful discussion of the results, how they align with past research, new findings, implications, and future research recommendations.

Chapter II

Literature Review

This study investigated if flipped learning changes critical thinking disposition. The review of literature will explore three areas: the theoretical framework of the study, flipped learning, and critical thinking disposition. Collectively, these areas formed the basis of this research project, and will demonstrate the effectiveness of flipped learning, and its impact on critical thinking disposition.

Theoretical Framework

The theoretical framework for this study was *The Learning Cycles,* created by Robert Karplus. Based on his observations and study of Jean Piaget, he reasoned learning was an active process and that to learn new concepts and thought patterns students need to relate those experiences to existing knowledge. This notion is the basis of constructivist theory (i.e., knowledge is built on existing knowledge structures). This observation and thought process led Karplus (1980) to develop the learning cycles, and there are three distinct phases: exploration, concept introduction, and concept application. Table 1 provides definitions and explanations of each phase.

Table 1. *The Learning Cycles.*

Phase	Definition	Explanation

Table 1. cont.

Phase	Definition	Explanation
Exploration	"In this phase they explore new materials, ideas, and relationships with minimal guidance or expectations of accomplishments (Karplus, 1980, p. 6).	The exploration phase takes place before class.
Concept Introduction	Take knowledge from exploration phase and start to provide context to it.	The conceptual phase is conducted in class.
Concept Application	Apply the concepts to new information.	The application phase is conducted during and after class.

Exploration Phase. Students start the learning cycle at the exploration phase; new information is assimilated, which causes disequilibrium The new information should be challenging, but not too challenging, or students are is likely to quit. Some familiarity with this new information is essential, so that students' can begin to manipulate it based on prior knowledge. Disequilibrium and manipulation prepare the students for the conceptual phase (Karplus, 1980; Libby, 1995; Meyers, 1986).

Students in the flipped learning model start by exploring the material by viewing recorded lectures or specific instructional media. Also, worksheets and readings can be assigned to help exploration. The key is that students' equilibrium is disrupted by the assimilation of new information, and new ideas and hypotheses are constructed based on past knowledge.

Concept Introduction. Contexts are important to move new information from the knowledge level to the comprehension level. Students are asked to describe what they learned

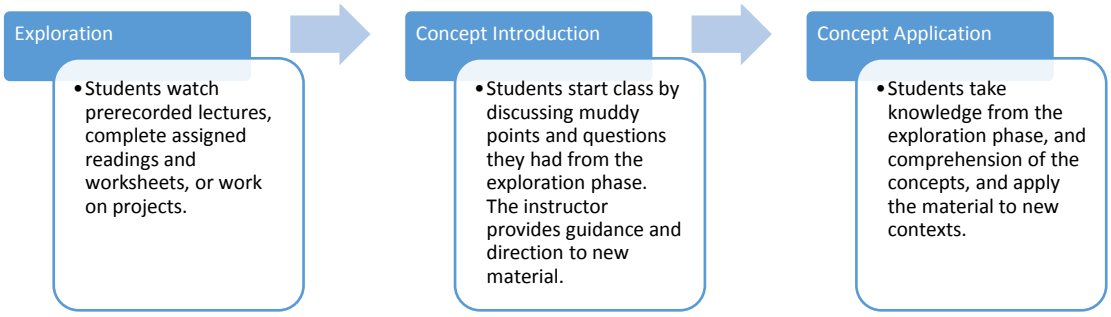
during the exploration phase, and faculty provide students context by suggesting models, theories, or stories that help explain the content (Zollman, 1990).

In the flipped model, students arrive in the classroom ready to use the knowledge they learned from the exploration phase. Small group discussions can be used to give the students the opportunity to test their new knowledge, and hear what their peers learned. Faculty can guide the students by presenting questions for discussion. To ensure students are able to apply concepts correctly, peer interaction and instructor guidance are essential.

Concept Application. Concept application involves taking concepts and relating them to new contexts. The application phase provides students the opportunity to reinforce newly learned knowledge and skills. During this phase of the model, faculty serve more as a mentor, helping students take conceptual knowledge, and apply it to new situations. Any combination of group work, case studies, and guided discussions can be used in class to promote the application of concepts (Meyers, 1986; Zollman, 1990).

The learning cycle theory provides the theoretical framework needed to ground flipped learning, and to guide the literature review and methodology sections of this research project (Figure 1). As students' progress through the learning cycles, they move from concrete thinking (exploration phase) to reasoning in the application phase. Students build new knowledge structures based on existing knowledge structures, the basis of constructivism.

Figure 1. *Flipped Learning Applied to the Learning Cycle*



Flipped Learning

Flipped learning combines two learning approaches: lecture and active learning. The lecture gives faculty a method to demonstrate expertise to students, passing on valuable knowledge from their experiences. The problem is that the delivery of the lecture makes learning active for the lecturer, not the students. Students need to actively use this newly acquired information, exploring and hypothesizing, to facilitate comprehension and retention (Huba & Freed, 2000). Exploring and hypothesizing can lead to higher levels of learning, which is the goal of flipped learning. The flipped learning approach uses recorded lectures before class for factual information, and active learning during class to promote higher level learning. The use of these two approaches, in this sequence, has made flipped learning an exciting new teaching approach. Before exploring specific flipped learning research, it is helpful to understand the history of lecture and the resistance to move to more active learning teaching strategies.

Lecture

The lecture has been around since medieval times and has remained popular throughout the 20th century. The lecture has remained the dominant form of instruction, largely related to economics, and familiarity (to educators), as described in the following two sections.

Economics. The popularity of lecture on college campuses is driven largely by economics. From a monetary, time, and effort standpoint, lecture provides substantial value. Undergraduate enrollment in higher education increased from 10.8 million in 1970 to 17.7 million in 2012 ("Fast Facts," n.d.). Along with increasing enrollments in higher education, state and local appropriations declined from a peak of 60.3 percent in 1975, to 30.4 percent in 2010 ("State Funding: A Race to the Bottom," n.d.). The demand for resources, coupled with

decreased funding, has made lecture the popular choice, based purely on economics. The issue of increasing enrollment and declining appropriations is not likely to improve. Sentiments nationally are that higher education should be affordable and accessible to every U.S. citizen. Some may question the effectiveness of lecture; however, economically, lecture makes sense, and economics is currently driving the conversation in higher education.

Familiarity. There is no nationally aggregated data to confirm lecture is still the most popular form of instruction; however, surveys in economics and math provide a lens that shows the majority of faculty in those respective disciplines favor lecture (Bressoud, 2011; Watts & Schaur, 2011). The lecture showcases faculties' expertise, providing students a way to explore topics on a level that they are not capable of on their own. Stunkel (1999) captures the power and beauty of the lecture: "at its best, a lecture is a critical, structured, skillful, thoughtful discourse on questions and findings, delivered by a person who knows what he or she is talking about" (p. 424). The lecture provides a way for faculty to demonstrate their expertise, on topics that may be difficult for students, by modeling their thought process.

The use of lecture because of familiarity is not only borne out of preference; it is also out of necessity. Faculty are working long hours not only teaching, but doing research and service as well. The workload requirements of the professoriate make it difficult to spend extensive time researching and instituting new teaching approaches in the classroom; therefore, faculty continue teaching using a method such as lecture, that is familiar to them; an approach they were likely on the receiving end of as a student, and now are delivering themselves (Ziker et al., 2014).

Active Learning

Although lecture remains popular, another teaching approach known as active learning is showing promise, yet the idea of active learning is not a new concept in higher education, as

calls for it can be traced to the 1987 report by the American Association of Higher Education titled *Seven Principles for Good Practice*. The third of seven principles indicates learning should be active, and that the purpose of active learning is to promote interaction between students and faculty. This increased interaction is an essential component of active learning and critical to the overall intellectual and personal development of the students (Chickering & Gamson, 1987).

Prince (2004) provides a broad definition of active learning, "…any instructional method that engages the student in the learning process (p. 223)." In essence, this definition of teaching involves students in the learning process. This broad definition encompasses collaborative learning, cooperative learning, and problem-based learning. Unlike lecture, active learning connects teaching and learning, meaning students are processing the information as they learn the material, not listening passively.

Actively engaging students in the process of learning seems simple; yet, it is fraught with barriers, particularly in how faculty view their role. Education is rich in traditions, and as surveys indicate, lecture is a part of that tradition. Central to this tradition is the faculty perception that their role is at the front of the classroom, delivering "the lecture" to the students (Bonwell & Eison, 1991). The broader movement of active learning minimizes their expertise, effectively moving faculty to the side of the classroom. Change causes discomfort and creates anxiety. The long held tradition of faculty lecturing at the front of the classroom is being challenged, and this can be a difficult adjustment, yet the evidence suggests higher education needs to change.

A review of the literature indicates the primary proponent of active learning is the Science, Technology, Engineering, and Math (STEM) fields. A meta-analysis conducted by

Freeman et al. (2014) shows students in STEM courses who use active learning outperform traditional lecture courses in exam scores, and students were less likely to fail. The average effect size on exam scores was 0.47, falling just below what is considered large. Their findings validate an earlier meta-analysis that compared active learning to lecture and found similar effect sized (Ruiz-Primo, Briggs, Iverson, Talbot, & Shepard, 2011). A key finding in their study was failure rates, and how they quantified those rates monetarily. Out of the 29,300 students in their analysis, 33.8 percent of lecture students failed courses, and 21.8 percent of active learning students failed courses. These course failures translated to a 3.5-million-dollar tuition savings to the students in active learning classes. These findings also demonstrate that students engaged in active learning achieve higher academically, are less likely to fail, and as a consequence, the cost is lower. Given these findings, active learning is an educational approach that faculty, administrators, and stakeholders can align with and support.

Lecture and active learning are well researched approaches supported by empirical evidence (Bligh, 1998; Freeman et al., 2014). Educators need to understand the value of each method as well as its weaknesses; combining lecture and active learning results in flipped learning.

Flipped Learning Research

Jonathan Bergmann and Aaron Sams are considered the pioneers of flipped learning by many (Ash, 2012; K. Fulton, 2012; K. P. Fulton, 2012; Heo & Choi, 2014; Schaffhauser, 2009), yet a search of the literature reveals that the basic principles of flipped learning have been around since the mid-1990s (Meibom, Sadler, Moses, & Litzkow, 1994). Studies in the 1990s evaluated active and passive forms of instruction using web-based lecture software and student perceptions of inverted learning, known as flipped learning today. Jonathan Bergmann and Aaron Sams

popularized (not pioneered) flipped learning with their successes at Woodland Park High School chronicled in their book: *Flipped Learning: Gateway to Student Engagement.* Educators have been using the idea of flipped classrooms for some time, moving direct instruction outside of class, allowing time in class to be active and student-centered.

While Woodland Park and other schools (e.g., Clintondale High School) experienced success with flipped learning, the body of academic peer-reviewed research is small. Bishop and Verleger (2013) are the first and only study to date, to provide a synthesis of flipped learning studies. They made three observations from their review: studies focused on student perceptions, generally did not contain control groups, and did not adequately explain the conceptual and theoretical framework used in flipped learning. Therefore, a need exists to provide a theoretical framework for flipped learning and to determine empirically if students achieve higher academically. A thorough review of flipped learning was conducted to determine what has been studied, the methodology used in the studies, and the findings. The investigation uncovered two categories: student perceptions and academic achievement.

Student Perceptions. Students perceptions of the curriculum and teaching approaches may have a significant impact on their academic performance and intellectual development, and positive perceptions of flipped learning are essential to ensure successful student learning outcomes along with its continued growth (Ferreira & Santoso, 2008). Overall, the majority of studies found students preferred the flipped learning format, compared to lecture. Students' positive comments were: they liked working with peers, felt they learned more and were better prepared for practice, and felt more self-directed when the class was over. Students disliked that: the flipped class required more work than traditional lecture, that class was a little crazy at times, and some felt they were not being taught the material ("Applying flipped model to

establish lifelong learning.pdf," n.d.; Day & Foley, 2006; Franciszkowicz, 2009; Gannod, 2007; Garver & Roberts, 2013; Gaughan, 2014; McLaughlin et al., 2014; Jennifer Moffett & Mill, 2014; Toto & Nguyen, 2009).

A small number of studies measured students' perceptions longitudinally; they found that students resisted the flipped format early in the semester, yet their views changed positively as the semester progressed. Overall, the students liked the recorded lectures, yet their perceptions of how they should be utilized changed as the semester progressed. Initially, students tried to use the videos to study; however, as the semester progressed, they found that the videos were better for introducing new material and did not work well for studying (Day & Foley, 2006; Mason, Shuman, & Cook, 2013).

Student preferences, not just learning outcomes, plays a role in how teaching approaches are viewed by students. Overall, students have a positive perception of flipped learning, yet some findings show faculty need to improve the course experience by better explaining what flipped learning is, and showing the students how to utilize the recorded lectures. Student perceptions of the teaching approach and course structure are an important consideration, when determining how to teach specific content. A negative view of the approach and structure of the course can impact student learning and development.

Student Achievement. The literature review on flipped learning revealed a limited number of studies that used some form of a control group. In some studies, researchers used control groups from different semesters and failed to control for aptitude (GPA). The quality and a small number of studies make it difficult to claim empirically that flipped learning leads to higher student achievement. Overall, findings showed that students had higher academic

achievement in flipped learning classrooms (Day & Foley, 2006; Meibom et al., 1994; Jennifer Moffett & Mill, 2014).

Day and Foley (2006) found students in the flipped section had significantly higher grades than the lecture section. Students in the flipped section had statistically significant higher means scores on homework assignments, class projects, exams, and the final course grade. The results of this well-designed study show flipped learning can increase students' achievement, yet one study makes it difficult to claim flipped learning is a success.

A significant portion of the flipped literature consists of anecdotal claims and stories of how educators implemented the flipped learning approach into their classes. To move forward, educators need to build a body of scientific research that demonstrates students perform better academically in flipped classrooms, compared to traditional approaches.

Flipped learning is an exciting new teaching approach; however, there is a lack of empirical evidence affirming educators' anecdotal claims of increased student achievement and higher level learning. As flipped learning research moves forward, it will be vital to use control groups and provide more detailed methodology that goes beyond anecdotal claims of success, and move toward empirical evidence. This study aims to add to this body of research, and to build on past findings.

Critical Thinking Disposition

Historically, critical thinking can be traced to John Dewey as a reflective process. Columbus thought the world was round, but most believed the world to be flat. Dewey described Columbus's belief that the world was round as a "…reasoned conclusion" (Dewey, 1910, p. 5). This observation led to Dewey defining reflective thought as: "Active, persistent, and careful

consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends…" (p. 6).

Critical thinking was popularized in the 1980s by the notion that education should be "…the process of inquiry, learning and thinking, rather than in the accumulation of disjointed skills and senescent information" (Facione, 1990, p. 1). This notion led to questions about how to define critical thinking, and how educators teach and assess critical thinking. In 1987, the American Psychological Association convened a group of educators, known as the Delphi panel, to investigate these questions related to the state of critical thinking. The panel, which consisted of 46 experts, employed a qualitative approach, The Delphi Method that worked towards consensus answers on critical thinking (Facione, 1990).

The Delphi panel of experts found that critical thinking has two dimensions. The skills dimension consists of interpretation, analysis, evaluation, inference, explanation, and self-regulation, which are used to examine evidence and make reasoned judgments. The second dimension, disposition, is the desire to use those critical thinking skills. Critical thinking disposition can be described as having "…a critical spirit, a probing inquisitiveness, a keenness of mind, a zealous dedication to reason, and a hunger or eagerness for reliable information…" (American Psychological Association, 1990, p. 11). Critical thinking skills are vital; yet, one must have the inclination to use those skills, the disposition. Students must have the motivation to use their skills, or the value of those skills decreases (Facione, 2000a; Stupnisky, Renaud, Daniels, Haynes, & Perry, 2008).

Teaching and fostering a students' disposition to think critically is an important outcome of higher education. The development of disposition skills is important to ensure students are able to use critical thinking outside their current instructional setting, and as working

professionals. The American Psychological Association (1990) indicated that, "…it is important to consider ways of developing material, pedagogies, and assessment tools that are effective and equitable in their focus on these affective dispositions" (p. 13). Faculty need to ensure teaching approaches focus not only on what to think, but how to think. The acquisition of knowledge and skills is an important part of the education process, and just as important is the desire and ability to use those skills (Daud & Husin, 2004). Active teaching approaches, such as flipped learning, are important to develop a positive disposition to think critically.

Dispositional Studies

A review of literature investigating dispositional studies found two general types: comparative and longitudinal. Comparative studies looked at disposition differences between groups (e.g., nursing students in Hong Kong and Australia). Longitudinal studies investigated the dispositional change of groups over time. The following reviews important findings in dispositional research, and what those results mean for higher education.

Comparative Studies. Comparative studies provide a comparison between two groups at a given point in time within disciplines, cultures, and countries. The basis of comparative research is to learn something about the groups being compared and derive meaning through the differences or similarities. The studies reviewed indicate that culture likely plays a role in critical thinking disposition.

Culture has an impact on how people view themselves and others around them. These differences influence peoples' experiences, including cognition and motivation (Kitayama & Markus, 2014). A study conducted by Tiwari et al. (2003) compared the critical thinking dispositions of Chinese and Australian nursing students and found Australian nurses had a significantly higher disposition toward critical thinking. Overall normalized scores showed that

Chinese nursing students had a negative disposition toward critical thinking, and Australians had a positive disposition. The authors asserted that cultural differences might have played a role in lower critical thinking disposition scores of Chinese students. Asian cultures focus is on others, and ensuring interdependence with other people is high. Australian culture is similar to western culture, where independence and expressing individuality is valued. Sub-scale scores seem to confirm this assertion: Chinese nursing students scored lower than Australian nursing students in truth-seeking, open-mindedness, and maturity. A study conducted by Ip WY et al. (2000) found similar results in, that Chinese nursing students had an overall negative disposition toward critical thinking, and scored lower on the same sub-scales of truth-seeking, open-mindedness, and maturity. These findings suggest that the Chinese students in this study were less open to other perspectives, less likely to question deeply held beliefs, and were less inclined to seek multiple solutions than Australian nurses. Researchers should be aware of the effect culture may have on critical thinking disposition, and more specifically sub-scale scores.

The inquisitiveness sub-scale on the California Critical Thinking Disposition Inventory (CCTDI) measures the desire to learn, even when immediate use and application are not clear (Insight Assessment, 2015). Inquisitiveness was the highest score, and falls within the positive range, in studies examining Chinese and Japanese nursing students dispositions (Ip WY et al., 2000; Kawashima & Petrini, 2004; Tiwari A et al., 2003). High inquisitiveness scores cross cultural lines, as a study conducted on nursing students in the Midwest showed high positive inquisitiveness scores (Colucciello, 1997). Inquisitiveness is likely a skill most students, regardless of culture, will likely score "positively" on since it measures the motivation and desire to learn.

Truth-seeking, the desire to have "the best possible understanding of any given situation;

it is following reasons and evidence whereever they may lead…" (Insight Assessment, 2015, p. 18), is an important measure of disposition. A higher truth-seeking subscore indicates a lack of bias in the search for truth. Sub-scores from the literature show a negative or ambivalent attitude among students toward truth-seeking (Colucciello, 1997; Giancarlo & Facione, 2001; Ip WY et al., 2000; Kawashima & Petrini, 2004; Tiwari A et al., 2003). Truth-seeking can be a difficult skill for humans to cultivate. Students are trying to understand new knowledge, based on their existing knowledge, and if understanding is challenging (the fit is a little off), students accommodate to assimilate the information to achieve understanding. Accommodation invites bias; this belief explains why people hold onto their current views so tightly (Giancarlo & Facione, 2001). Facione et al. (1995) describe their view "from the data collected at scores of settings in a wide variety of contexts it would appear that the majority of us are disposed not to see the truth courageously and not pursue reasons and evidence wherever they might lead" (p. 8). This finding means that, regardless of the population being studied, truth-seeking will likely be the lowest score, and the most difficult behavior to change.

Longitudinal Studies. While comparative studies provide insight into group differences, longitudinal studies address how an environment affects disposition. The college environment has been shown to have a significant impact on student achievement (Astin & others, 1993). A large study on disposition changes in college was conducted by Giancarlo and Facione (2001). Students attending a small liberal arts college were administered the CCTDI their freshman year, and again their senior year. They found mean scores were consistent or higher across all seven sub-scales on the post-test. Statistically significant change over four-years was found in truth-seeking, self-confidence, and overall score. Students who moved from ambivalent to positive was greater than ambivalent to negative (an encouraging finding for higher education). Truth-

seeking was the lowest sub-score across all students, as previously discussed, and it can be a difficult skill to cultivate regardless of culture (Facione et al., 1995).

Two studies investigated at how disposition changed from year to year in students. Shin et al. (2006) and Colucciello (1997) examined yearly disposition change in an undergraduate nursing program, finding a significant change in overall scores between the sophomore, junior, and senior years. Another study, conducted by Stewart and Demsey (2005), did not find a statistically significant change in nursing students from sophomore to senior year.

While the aforementioned studies addressed dispositional change by academic year, Bartlett and Cox (2002) investigated change over an academic course. They measured the dispositional change of physical therapy students at the end of academics (seven months), and the end of clinical (twelve months). The greatest change in disposition occurred over academics, with a reported effect size of 1.01 (large). On the sub-scales, the most significant change occurred in truth-seeking and self-confidence.

The findings of these studies indicate that the college environment can have a positive impact on disposition, and that the greatest change is likely to take place in truth-seeking and self-confidence. Faculty need to create curriculum and use teaching approaches that promote critical thinking disposition. The college experience has to be about more than amassing knowledge and skills; students should be taught and provided opportunities to approach problems critically. Employers are asking for these skills and the ability to use them in new contexts, and faculty need to listen and cultivate these skills in students.

Correlations with Disposition. Three significant correlations were found examining the literature. Critical thinking disposition is positively correlated with critical thinking skills, age, and GPA. These are important variables that not only show that a relationship exists, but

that they may have and have an impact on research design.

The 1990 Delphi Report made the scholarly assertion that there should be a positive correlation between critical thinking skill and disposition (American Psychological Association, 1990). This assertion was confirmed, in that critical thinking skills have been found to have a positive correlation with critical thinking disposition (Colucciello, 1997; Giancarlo & Facione, 2001; Profetto-McGrath J, 2003). These findings show the importance disposition has on critical thinking skills, and that high disposition might indicate the ability to think critically. It should be noted that the correlations found in these studies were small, indicating a relationship exists, and also demonstrating skills and dispositions are independent (Stupnisky et al., 2008).

Grades and GPA measure a students' academic achievement. Therefore, it is important to understand if correlations exist between GPA and disposition. Overall, studies have shown a small correlation between GPA and disposition (Facione, 2000b; Giancarlo & Facione, 2001; Ip WY et al., 2000; Stedman, Irani, Friedel, Rhoades, & Ricketts, 2009). A correlation between GPA and critical thinking disposition might indicate to some degree, faculty reward higher dispositions with higher grades (Giancarlo & Facione, 2001).

Age was found to correlate with critical thinking dispositions. However, most studies failed to report age as a demographic variable. If further research examines disposition and cognitive development, age is a critical variable. Several studies show a significantly higher disposition in seniors compared to sophomores (Colucciello, 1997; McCarthy P, Schuster P, Zehr P, & McDougal D, 1999). This research indicates that some component of the dispositional score may be a component of cognitive development. Comparative studies need to ensure that the groups being studied do not have significant age differences, and longitudinal studies need to identify the mean age of the participants, and any extreme outliers that may have skewed the

results (significantly older or younger than the population being studied). Age is an important demographic variable that should be considered when researching disposition.

Summary of Literature

The benefits of flipped learning are derived from having students view recorded lectures before class, and then using their new knowledge actively in the classroom. The research on active learning demonstrates higher student achievement compared to lecture, and some economic advantages. Yet, the familiarity of lecture, traditions in higher education, and increasing faculty workload requirements have kept lecture the dominant teaching approach in higher education. This situation is concerning, because the empirical evidence shows lecture is successful at transferring facts(Bligh, 1998), yet employers are asking for better critical thinking skills and higher educations approach to teaching remains largely unchanged.

While flipped learning is an important development in higher education that is showing promise, a lack of empirical evidence makes the claims largely anecdotal. Claims of greater student achievement and higher order thinking skills are not supported by the literature of flipped learning. These higher order thinking skills, and the disposition to use them are important educational outcomes to ensure students are ready for the global workforce. Educators need to find teaching approaches that use active learning and cultivate critical thinking dispositions.

In summary, the review of literature led to three conclusions: 1) more controlled studies of flipped learning are needed to validate student achievement is higher in flipped classrooms compared to traditional approaches; 2) there is a need to study pedagogical approaches to determine if they affect critical thinking disposition; and 3) indentifying the theoretical frameworks that help explain flipped learning is important. This proposal will address this gap in the research by exploring if flipped learning changes critical thinking disposition and by

providing a theoretical framework for flipped learning.

CHAPTER III

METHODOLOGY

Various studies have analyzed student perceptions of flipped learning, yet there is still a significant gap in the literature regarding how flipped learning affects academic achievement and critical thinking. This study addressed this gap, by conducting a quasi-experimental controlled study on flipped learning and critical thinking disposition. In this chapter a description of the research design, instruments for data collection, data collection, procedures, and timelines are provided.

Purpose of the Study

The purpose of this study was to examine if flipped learning has an effect on students critical thinking disposition and how student perceptions of flipped learning change during the semester. The following research questions directed this study:

1. Does flipped learning change students' critical thinking disposition?
2. Do students' perceptions of flipped learning change during the semester after engaging in flipped learning?
3. Do students in a flipped learning course perform better academically than students in a lecture course?

Research Design

This study used a longitudinal, quasi-experimental research design to answer the research questions. The study utilized a convenience sample of students enrolled in a sophomore level human factors aviation course. The research design for this project was guided by the Day and Foley (2006) study and the Tiwari, Sai, So, and Yuen (2006) study. Day and Foley (2006) were the first to employ a longitudinal design in flipped learning research (Bishop & Verleger, 2013). The Tiwari et al. (2006) study compared the effects that Problem-Based Learning (PBL) and lecture had on critical thinking disposition over one academic year.

A control group was used to provide a reliable baseline comparison to measure the change in scores between the lecture section, and a flipped section of the human factors course. The study took place in a naturalistic setting over one college semester (16 weeks). A pretest/posttest design was employed to measure longitudinal changes in student dispositions and how their perceptions of flipped learning change during the semester. Academic performance was measured through two block exams, and one final exam.

Participants

Student participants in this study attended a large research university at the time of the study, located in the upper Midwest. A total of 109 students participated across 16 weeks: 56 students in the flipped section and 53 in the lecture section. The students in the flipped learning section met once each week on Friday from 9-10:50 AM. The lecture section meet two times per week on Mondays and Wednesdays from 1-1:50 PM. To ensure participants in the study adequate exposure to the treatment, students in the flipped section could only miss a maximum of three classes (6 hours total), and students in the lecture section could miss a maximum of six classes (6 hours total). Forty-three students in the flipped section, and 38 in the lecture section

completed all of the course work, surveys, and met the minimum attendance requirement of the study. In the flipped section, 11 students missed more than three classes, and were dropped, with two students choosing not to participate. In the lecture section, 10 students missed more than six classes, with five choosing not to participate.

As the researcher, I taught both sections of the class. In a naturalistic setting, having one faculty member teach both sections provided some control between the two sections (Day & Foley, 2006). The flipped section used a Graduate Teaching Assistant (GTA) to assist with the logistics of a large, active learning course.

Characteristics. Participants who volunteered for the study answered demographic questions on the first Course Evaluation Survey (week 4). Demographic information collected included gender, age, ethnicity, status as a student, and if they had ever taken a course that was flipped. The researchers obtained GPA directly from the institutional database, as research has shown students over report their GPA (Kuncel, Credé, & Thomas, 2005), making it necessary to obtain the official GPA .

The mean age of participants was 20.67 years of age (SD 3.97), with a minimum of 18, and a maximum of 42. There were 71 males (87.7 percent), and 4 females (4.9 percent). Large differences in gender are representative of the aviation student population. Six participants (7.4 percent) chose not to respond to the gender question. The majority of participants were white (61), the next largest group was Asian (10). Most of the participants were freshmen (24) or sophomores (36), with 15 reporting as upper classman (juniors or seniors). Participants had a mean GPA of 3.34 (*SD*=.78). The majority of students (80.2 percent) had not taken a flipped course previously. Table 2 provides a summary of the study participants' characteristics.

Table 2. *Demographic Characteristics of Flipped Study Participants*

Characteristics		N
Gender	Male	71
	Female	4
	Missing	6
Class	Freshman	24
	Sophomore	36
	Junior	12
	Senior	3
	Other	1
Ethnicity	Caucasian	62
	American Indian	1
	Mexican American	1
	Asian	10
	Other	2
	Missing	5
Previous Flipped Experience	Yes	11
	No	65
	Missing	5

Course Description

Human Factors in aviation is a sophomore level course designed to develop a broad understanding of human cognition, human interaction, and man-machine interface in aerospace operations. The course has three blocks: human cognition, human interaction, and man-machine interface. Block one explores memory, bias, attention types, error, and decision making. Block two examines culture and gender issues, attitudes, personalities, group formation, communication, leadership, and situational awareness. Block three examines information systems, visual displays, and auditory displays.

Coursework and assessments consisted of quizzes, worksheets, reflections, a group project, block exams, and a final exam. The flipped learning section and the lecture section covered the same content and completed the same coursework throughout the semester. Table 3 shows the steps each lecture and flipped lesson will follow.

Table 3. *General Steps Lecture and Flipped Lessons Will Follow.*

	Lecture	Flipped
Step 1	Complete assigned readings	Watch recorded lecture before class.
Step 2	Attend class and listen to lecture	Complete a quiz on recorded lecture material at the start of class.
Step 3	Complete quiz at the end class	Participate in active learning exercises during the class period.
Step 4	N/A	Take post quiz.

Instruments for Data Collection

Two instruments were selected to investigate critical thinking disposition and the students'perceptions of flipped learning: the California Critical Thinking Disposition Inventory (CCTDI) and the Course Evaluation Survey (CES). Some revision to wording on CES were made to address cultural difference. It should be noted that the CES has been modified and used in various studies and settings, and is also referred to as the Course Evaluation Questionnaire (CEQ).

CCTDI. In response to the Delphi study, Drs. Peter and Noreen Facione created the CCTDI to measure critical thinking disposition. Seven scales, intermixed throughout the seventy-five questions, are measured on a six-point Likert scale that ranges from "strongly

disagree" to "strongly agree" (Insight Assessment, 2015). The seven constructs measured, along with definitions are illustrated in Table 4.

Table 4. *CCTDI Constructs*

Construct	Definition
Truth-Seeking	"…is the habit of always desiring the best possible understanding of any given situation" (Insight Assessment, 2015, p. 18).
Analyticity	"…is the tendency to be alert to what happens next" "…is the tendency to allow other to voice views with which one may not agree" (Insight Assessment, 2015, p. 18).
Open-mindedness	"…is the tendency to allow other to voice views with which one may not agree" (Insight Assessment, 2015, p. 18).
Systematicity	"…is the tendency or habit of striving to approach problems in a disciplined, orderly, and systematic way" (Insight Assessment, 2015, p. 18).
Confidence in Reasoning	"…is the habitual tendency to trust reflective thinking to sol ve problems and to make decisions" (Insight Assessment, 2015, p. 18).
Inquisitiveness	"…is intellectual curiosity" (Insight Assessment, 2015, p. 18).
Maturity in Judgement	"…is the habit of seeing the complexity of issues and yet str iving to make timely decisions" (Insight Assessment, 2015, p. 18).

The CCTDI is not content specific and applies to individuals from high school to working professionals. The test has a 30-minute time limit, yet most participants finish the test within 15-20 minutes (Insight Assessment, 2015).

The CCTDI reports eight scores, one for each of the seven sub-scales, and an overall score. The overall score ranges from 70 to 420 and provides general insight into the participant's critical thinking mindset. Each of the scale scores range from 10 to 60 and are considered independent (Insight Assessment, 2015). In Table 5, a summary of score ranges and definitions are provided.

Table 5. *CCTDI Scale Score Ranges and Definitions*

Category	Score	Qualitative Interpretation
Strong Positive	50-60	Strong positive attitude and qualities towards critical thinking.
Positive	40-49	Positive attitude and qualities towards critical thinking.
Inconsistent/Ambivalent	30-39	Inconsistent attitude and qualities toward critical thinking.
Negative	20-29	Limited and restricted approach towards critical thinking.
Strong Negative	10-19	Strong limited and restricted approach towards critical thinking.

CES. The CES was created by Paul Ramsden to explore student perceptions of the quality of courses they had completed (Ramsden, 1991; Ramsden & Entwistle, 1981). Five constructs are "intermixed" within twenty-four, five point, Likert-type questions ranging from "strongly disagree" to "strongly agree." The five constructs examined by the CES are: teaching, goals and standards, assessment, workload, and skills. The final question on the CES, which is not part of a construct, asks a student to rate overall course satisfaction. The CES has been extensively used in higher education, in that over 50,000 university graduates have been

administered the instrument (Ainley & Long, 1994). The codebook for the CES is located in Appendix A.

Validity and Reliability of Instruments. An investigation of the literature showed both the CCTDI and the CES were valid and reliable instruments. A study conducted by Broomfield and Bligh (1998) validated the use of the CES by "…demonstrating satisfactory construct validity and reliability for the inventory" (p. 367). A recent study on flipped learning by Moffett and Mill (2014) used the CES (called the CEQ in their study) to measure student perception and reported a Cronbach Alpha of .83, indicating the instrument is consistent and reliable.

The validity of the CCTDI originates from the Delphi study and a growing body of literature. The *CCTDI User Manual* provides a description of how the creators ensured content validity (Insight Assessment, 2015):

> Multiple pilot item prompts were written to capture the consensus description of the ideal critical thinker. The development of item prompts in the form of attitudinal items characterized the development of the CCTDI. The resulting 250 prompts were screened by college level critical thinking educators and researchers skilled in survey research and instrument development to identify those items least subject to ambiguity and misinterpretation (p. 53).

The growing body of research on the CCTDI in the U.S. and other countries demonstrates criterion validity; the instrument is being used to relate and predict "…behavior external to the instrument itself" (Insight Assessment, p. 54).

Reliability of the CCTDI is calculated by Insight Assessment using historical testing data. Initial pilot studies found internal reliability to be .71 to .80 on the seven subscales, and .91 for the overall instrument. Samples collected over the last 15 years found internal reliability for the

scales ranging from .68 to .78, and .90 for the overall instrument. Test-retest studies demonstrated reliability; the reported coefficients exceeded .80 (Insight Assessment, 2015).

Instrument Measure Quality

Prior to performing statistical tests, the data was analyzed for normality. Because this is a longitudinal study, the data will be presented in two parts, pre and posttest for the CES and CCTDI. Shown in Table 6 are pretest and posttest descriptive data for the summed CES variables, and shown in Table 7 are pretest and posttest descriptive data for the summed CCTDI variables. Analysis indicates the scales were normally distributed, except that two scales on the CES showed minor normality issues (skewness > 1). The goals scale on the pre-test, and the goals and teaching scale on the post-test are moderately non-normal (Lei & Lomax, 2005). Prior to summing the scales on the CES, internal reliability was calculated and indicates good reliability. Assessment and workload were slightly low on the post-test CES. The CCTDI testing instrument and software are proprietary, and only the summed scales were provided; therefore, reliability was not calculated. Reliability of the CCTDI has been extensively cited in the literature.

Table 6. *Descriptive Data for CES Variables*

Scale	N	Possible Range	Actual Range	*M*(SD)	Skewness	Kurtosis	Cronbach's Alpha
Pre-Test							
Teaching	76	1-5	2-4.83	3.84(.50)	-.573	1.316	.79
Goals	79	1-5	2.25-4	3.61(.34)	-1.344	3.398	.74
Assessment	76	1-5	1.33-4.67	2.88(.81)	.501	-.580	.82
Workload	76	1-5	1-4	2.40(.60)	.088	.758	.70
Skills	76	1-5	2-5	3.52(.59)	-.178	.145	.86
Post-Test							
Teaching	79	1-5	1.50-5	4.13(.60)	-1.289	3.75	.85
Goals	79	1-5	2.25-4	3.61(.34)	-1.344	3.398	.73

Table 6. cont.

Scale	N	Possible Range	Actual Range	*M*(SD)	Skewness	Kurtosis	Cronbach's Alpha
Assessment	79	1-5	1.33-5	2.73(.72)	.342	.134	.53
Workload	79	1-5	1-3.75	2.30(.57)	.317	-.009	.68
Skills	79	1-5	2-5	3.68(.65)	-.342	.330	.86

Table 7. *Descriptive Data for CCTDI Variables*

Scale	N	Possible Range	Actual Range	*M*(SD)	Skewness	Kurtosis
Pre-Test						
Overall	75	70-420	243-366	291.99(26.93)	.215	-.302
Truthseeking	75	10-60	18-48	35.65(5.52)	-.427	.842
Open Mindedness	75	10-60	27-54	40.77(5.92)	-.303	-.540
Analyticity	75	10-60	34-58	45.01(5.20)	.166	-.301
Systematicity	75	10-60	24-56	40.29(6.53)	-.095	-.069
Confidence in Reasoning	75	10-60	26-56	43.47(5.77)	-.345	.319
Inquisitiveness	75	10-60	30-58	45.53(6.52)	-.039	-.498
Maturity of Judgement	75	10-60	26-56	41.51(5.48)	-.175	1.255
Post-Test						
Overall	76	70-420	232-359	290.72(25.99)	.227	-.175
Truthseeking	76	10-60	22-56	36.39(5.62)	.206	1.621
Open Mindedness	76	10-60	27-52	40.78(5.60)	-.496	-.122
Analyticity	76	10-60	32-55	44.35(5.13)	-.094	-.412
Systematicity	76	10-60	25-52	39.61(5.80)	.161	-.400
Confidence in Reasoning	76	10-60	27-54	42.74(5.70)	-.265	-.362
Inquisitiveness	76	10-60	31-58	45.42(6.06)	-.270	-.279
Maturity of Judgement	76	10-60	26-57	41.72(6.17)	-.342	-.087

Table 8 shows descriptive data for the block one exam, the block two exam, and the final exam. Each block exam is broken down into four parts: the overall score, knowledge level, comprehension level, and application level. The descriptives shows that the data ranges from normal to moderately nonnormal (skewness slightly above one).

Table 8. *Descriptive Data for Course Exams*

	N	Possible Range	Actual Range	*M*(SD)	Skewness	Kurtosis
Block 1 Exam						
Overall	81	0-100	53-98	83.73(8.70)	-.898	1.272
Knowledge		0-13	7-13	11.70(1.46)	-1.141	1.272
Comprehension		0-13	5-13	10.65(1.68)	-1.430	2.470
Application		0-14	5-13	11.00(1.62)	-1.302	2.222
Block 2 Exam						
Overall	81	0-100	48-98	81.35(9.81)	-1.210	2.254
Knowledge		0-13	8-13	11.77(1.30)	-.713	-.407
Comprehension		0-13	4-13	10.72(1.93)	-1.061	1.127
Application		0-14	6-13	10.00(1.64)	-.475	-.069
Final Exam						
Overall	81	0-100	58-100	89.11(7.52)	-1.181	2.55
Knowledge		0-20	13-20	19.09(1.41)	-2.006	5.225
Comprehension		0-15	1-15	12.69(1.76)	-.688	.512
Application		0-15	8-15	12.74(1.74)	-.747	.343

Data Collection

Students completed the CES on Qualtrics®, an online survey tool. The CCTDI was administered using scantrons, and the results were sent to Insight Assessment for reading. The CES was administered on Qualtrics®, and the students completed the survey on their own electronic device. Students completed course block exams using the traditional paper-pencil

format. Scores from the CES, CCTDI, and the block exams were downloaded into Microsoft Excel for sorting and coding before being transferred to SPSS® statistical software for analysis.

Missing Data

Missing data on the CCTDI will be discarded under two conditions addressed in the *CCTDI User Manual*: the student takes less than five minutes to complete the instrument, and/or the student does not complete at least 60 percent of the instrument (Insight Assessment, 2015). Completing a 75 question assessment in five minutes or less indicates a lack of cognitive effort, which violates the assumption stated in Chapter I (that the student made every effort to respond to the survey accurately and truthfully). Missing scores on the CES were omitted from the study. Students who did not complete one or more block exams were dropped from the study, as they were likely to fail the course.

No participant that started the CCTDI completed less than 99 percent, and 100 percent of the CES was completed. There were no participants dropped from the study for missing the block exams or final.

Human Subjects Approval

The required Institutional Review Board (IRB) training and approval was completed before the start of data collection. Students were informed about the study on the first day of the course, and told participation was voluntary. If students chose to participate in the study, they received a paper copy of the informed consent form. Participants had access to a copy of the IRB approval letter, which was posted on the course Learning Management System (LMS) site. Acknowledgment of informed consent was confirmed by completing the surveys. Students were offered eight extra credit points on the final exam for participating in the study.

Procedures and Timeline

The study was conducted during the Spring semester over a 16-week period from January 11, 2016 to May 13, 2016. During the first week of the course, students were informed of the study and asked if they had a desire to participate. Students who volunteered to participate in the study completed the CCTDI in week two, and the CES in week 4 (pre-test). In week 15, students completed the CCTDI and the CES (post-test). Exam scores from the students who chose not to participate in the study were excluded from the analysis. Students were offered eight extra credit points on their final exam, if they volunteered to participate. An alternative extra credit assignment was offered to students who chose not to participate in the study. Provided in Table 9, is a summary of the research timeline.

Table 9. *IRB and Testing Timeline (16 Week Course)*

Academic Week	Task
1	IRB
2	Administer CCTDI
4	Administer CES
15	Administer CCTDI and CES

Summary

This chapter provided a detailed description of the research design, instruments for data collection, data collection, and procedures and timelines. Specifics on the statistical tests and the results of the survey are presented in the next chapter.

Chapter IV

Results

The purpose of this study was to examine whether flipped learning has an effect on students' critical thinking disposition, how student perceptions of flipped learning change longitudinally during the semester, and do students in a flipped classroom perform better academically. The following research questions guided this study:

1. Does flipped learning change students critical thinking disposition?
2. Do students perceptions of flipped learning change during the semester?
3. Do students in a flipped learning course perform better academically than students in a lecture course?

Data Analysis

After sorting and coding the data in Microsoft Excel, the data was moved to Statistical Package for Social Sciences (SPSS®) 22 software for analysis. Provided in Chapter III, are the basic descriptive statistics, reliability, skewness, and kurtosis information for the data set. This chapter provides the necessary statistical analysis to answer each of the research questions. An alpha level of .05 was used for all statistical tests. The results are grouped by research question, and include a short description of the statistical tests used. An abbreviated narrative of the results, and corresponding tables are provided where appropriate.

Research Questions

Research Question 1: Does flipped learning change students' critical thinking disposition?

To determine if flipped learning changes a student's critical thinking disposition, two statistical tests were selected, an independent samples *t*-test, and a paired-samples *t*-test (dependent samples test). The paired samples *t*-test was conducted to investigate if a student's disposition changed from the pre-test to post-test (within groups), and the independent samples *t*-test was used to determine if a significant difference exist between the lecture and flipped groups (between groups) (Table 10). The results of the CCTDI are broken down by the overall score and the seven subsections: truthseeking, open mindedness, analyticity, systematicity, confidence in reasoning, inquisitiveness, and maturity of judgement. The alpha level for all statistical tests was set at .05, and effect size was calculated for the results which rejected the null hypothesis (significant).

Table 10. *Within and Between Groups Testing*

	Groupings	Statistical Test	Remarks
Within Groups	Lecture Pre-Test to Lecture Post-Test Flipped Pre-Test to Flipped Post-Test	Paired Samples *t*-Test	To determine if significant differences occurred longitudinally.
Between Groups	Lecture versus Flipped (Δ)	Independent Samples *t*-Test	To determine if significant differences occurred between the control group (lecture) and flipped group.

Overall CCTDI Results

Prior to running statistical analyses, the data file was split based on the studies grouping variable, lecture and flipped. Table 11 shows the mean scores comparison from the pre-test to

post-test for both the lecture and flipped sections. Overall scores on the CCTDI were not significant in either the lecture and flipped groups.

Table 11. *Overall Within Groups Results for the CCTDI*

Variable: Overall	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-2.12*	.874	33	.388	
Pre-Test	34	294.62	29.40					
Post-Test	34	292.50	29.25					
Flipped				-0.81*	.242	35	.811	
Pre-Test	36	289.89	25.71					
Post-Test	36	289.08	20.85					

*A negative number indicates a decrease from the pre-test to post-test score.

Subscore CCTDI Results

While the overall results provide insight into a participant's or group's overall disposition, the overall score can mask findings at a more granular level, such as specific strengths and weaknesses an individual has with a high score (Insight Assessment, 2015).

Prior to running sub score analyses, the groups (lecture and flipped) were split to investigate the changes from pre-test to post-test within each group. The results are broken down by the subscore variables, and then by groupings.

Truthseeking. To examine the truthseeking variable, a paired samples *t*-test was conducted to determine if significant differences existed between the pre-test and posttest within the flipped and lecture groups. Overall, the results in both groups were not significant; however, the results in the flipped section were intriguing, as the mean score increased from the pre-test (*M*=34.83) to the post-test (*M*=36.36), a mean increase of 1.53 (Table 12).

Table 12. *Truthseeking Variable*

Variable: Truthseeking	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-0.18*	.222	33	.826	
Pre-Test	34	36.62	4.74					
Post-Test	34	36.44	6.43					
Flipped				1.53	-1.69	35	.09	
Pre-Test	36	34.83	6.24					
Post-Test	36	36.36	5.30					

*A negative number indicates a decrease from the pre-test to post-test score.

A paired samples *t*-test was conducted to examine mean differences of the flipped and lecture openmindedness variable. Table 13 shows the results in the flipped section were significant, with an increase in the mean from pre-test (*M*=39.44) to post-test (*M*=40.64), and a small effect size (*d*=.34). Cohen's d was calculated using Morris and Deshons (2002) correction for dependence between means. The results indicate that students in the flipped section tolerance and openness to others viewpoints and opinions increased significantly over the course of the semester.

Table 13. *Openmindedness Variable*

Variable: Open-Mindedness	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-0.17*	1.116	33	.272	
Pre-Test	34	41.59	6.40					
Post-Test	34	40.76	5.33					
Flipped				1.2	-2.050	35	.048	.34
Pre-Test	36	39.44	5.46					
Post-Test	36	40.64	5.72					

*A negative number indicates a decrease from the pre-test to post-test score.

To examine the analyticity variable, a paired samples *t*-test was used to test mean differences. Analyticity scores in the flipped and lecture section were not significant. In Table 14 the results of the analysis are summarized.

Table 14. *Analyticity Variable*

Variable: Analyticity	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-.62*	0.906	33	.372	
Pre-Test	34	45.27	4.87					
Post-Test	34	44.65	4.50					
Flipped				-.021*	1.093	35	.282	
Pre-Test	36	45.08	5.64					
Post-Test	36	44.08	5.43					

*A negative number indicates a decrease from the pre-test to post-test score.

A paired samples *t*-test was conducted to examine the mean differences within the lecture and flipped groups systematicity variable. The results, summarized in Table 15, show no significant differences from pretest to posttest for the lecture or flipped sections.

Table 15. *Systematicity Variable*

Variable: Systematicity	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-0.77*	.844	33	.405	
Pre-Test	34	40.59	7.25					
Post-Test	34	39.82	6.88					
Flipped				-1.08*	1.685	35	.101	
Pre-Test	36	40.47	5.82					
Post-Test	36	39.39	4.82					

*A negative number indicates a decrease from the pre-test to post-test score.

To examine the within group differences of the lecture and flipped groups confidence in reasoning variable, a paired samples *t*-test was conducted. The results, summarized in Table 16, show no significant differences from pretest to posttest for the lecture or flipped sections.

Table 16. *Confidence in Reasoning*

Variable: Confidence in Reasoning	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-.71*	1.106	33	.277	
Pre-Test	34	43.92	6.27					
Post-Test	34	43.21	5.62					
Flipped				-0.36*	.728	35	.471	
Pre-Test	36	43.31	5.06					
Post-Test	36	42.67	5.18					

*A negative number indicates a decrease from the pre-test to post-test score.

To test the within group differences of the lecture and flipped inquisitiveness variable, a paired samples *t*-test was conducted. Inquisitiveness scores in the flipped and lecture section were not significant. Table 17 summarizes the results of the analysis.

Table 17. *Inquisitiveness Variable*

Variable: Inquisitiveness	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				0.38	-.622	33	.538	
Pre-Test	34	45.24	6.79					
Post-Test	34	45.62	6.73					
Flipped				-0.25*	.248	35	.805	
Pre-Test	36	45.53	6.66					
Post-Test	36	45.28	5.66					

*A negative number indicates a decrease from the pre-test to post-test score.

A paired samples *t*-test was conducted to examine the mean differences within the lecture and flipped groups maturity of judgement variable. The results, summarized in Table 18, show no significant differences from pretest to posttest for the lecture or flipped sections.

Table 18. *Maturity of Judgement Variable*

Variable: Maturity of Judgement	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				0.61	-.703	33	.487	
Pre-Test	34	41.65	5.08					
Post-Test	34	42.26	6.85					
Flipped				-0.53*	.690	35	.495	
Pre-Test	36	41.47	6.11					
Post-Test	36	40.94	5.26					

*A negative number indicates a decrease from the pre-test to post-test score.

Group Differences Results for the CCTDI

CCTDI Results. To begin the between groups analysis (lecture versus flipped), a delta (Δ) value was calculated for the pre-test to post-test score for the lecture and flipped groups, creating a new variable.

X_1=pretest scores

X_2=posttest scores

D (Δ) =X_1-X_2

(e.g. Lecture X_1 – Lecture X_2 = (Δ) D)

Each difference score was then used to determine if between group differences existed between the lecture (control) and flipped section for the CCTDI overall score, and seven subscale scores.

An independent samples *t*-test was conducted to analyze the difference in mean scores on the CCTDI between the lecture and flipped section. Table 19 shows a comparison between the

lecture and flipped group for the overall and subscales scores. The results show a significant difference between the flipped and lecture section deltas open mindedness variable $F(68)=2.16$, p=.034, meaning students in the flipped section openmindedness score improved significantly compared to the lecture section.

Table 19. *Lecture and Flipped Group Difference Scores.*

Variable	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Overall				1.31	.315	68	.754	
Lecture	34	-2.12	14.12					
Flipped	36	-.81	20.01					
Truthseeking				1.7	1.410	68	.163	
Lecture	34	-.18	4.64					
Flipped	36	1.52	5.42					
Open-Mindedness				2.01	2.159	68	.034	.51
Lecture	34	-.82	4.30					
Flipped	36	1.19	3.49					
Analyticity				.38	-.332	68	.741	
Lecture	34	-.62	3.98					
Flipped	36	-1.00	5.49					
Systematicity				.32	-.289	68	.773	
Lecture	34	-.76	5.28					
Flipped	36	-1.08	3.86					
Confidence in Reasoning				.07	.061	68	.951	
Lecture	34	-.71	3.72					
Flipped	36	-.64	5.27					
Inquisitiveness				.63	-.536	57.47	.594	
Lecture	34	.38	3.58					
Flipped	36	-.25	6.04					
Maturity of Judgement				1.15	-.986	68	.327	
Lecture	34	.62	5.12					

Table 19. cont.

Variable	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Flipped	36	-.53	4.59					

Research Question 2: Do students perceptions of flipped learning change during the semester?

To determine if the students perceptions changed during the semester, two statistical tests were used, an independent samples *t*-test, and a paired-samples *t*-test, to analyze the results of the CES survey given in week 4 (pre-test), and again in week 15 (post-test). The paired samples *t*-test was used to investigate if a student's perceptions changed within their group (e.g, lecture pre-test to lecture post-test), and the independent samples t-test was used to determine if a significant difference existed between the lecture and flipped groups (lecture versus flipped).

The results of the CES are broken down by their summed scales which are named: teaching, goals, assessment, workload, and skills. In addition to the scales, one question was asked regarding how satisfied a participant was with the course. The alpha level for all statistical tests was set at .05, and effect size was calculated for the results which rejected the null hypothesis (significant). Prior to running the paired sample *t*-tests, the file was split based on the grouping variable, lecture and flipped.

Overall Course Satisfaction

A paired samples *t*-test was conducted to examine if within group differences of the lecture and flipped groups course satisfaction variable. Table 20 shows the mean score comparison from the pre-test to post-test for both groups. Satisfaction scores in the lecture section increased significantly $t(36)=-2.707$, $p=.010$, indicating students were more satisfied with the lecture course at the end of the course when compared to the beginning of the course. Scores

in the flipped section were not significant, however, the mean increased slightly from the pre-test to post-test.

Table 20. *Overall Course Satisfaction Variable*

Variable: Course Satisfaction	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				0.35	-2.707	36	.010	-.443
Pre-Test	37	3.95	.62					
Post-Test	37	4.30	.62					
Flipped				.11	-.644	37	.524	
Pre-Test	38	3.92	.85					
Post-Test	38	4.03	.94					

CES Constructs Analysis. A paired samples *t*-test was conducted to determine if mean differences existed within the teaching variable. The results, summarized in Table 21, show that lecture and flipped sections teaching scale was significant. The means in both groups increased from the pre-test the post-test, indicating the students felt that the teaching had improved at the end of the semester.

Table 21. *Teaching Variable*

Variable: Teaching	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				.36	-4.019	36	.000	-.667
Pre-Test	37	3.79	.36					
Post-Test	37	4.14	.51					
Flipped				.23	-2.071	37	.045	-.347
Pre-Test	38	3.90	.61					
Post-Test	38	4.13	.69					

A paired samples *t*-test was run to examine the within group mean differences of the lecture and flipped groups for the goals and standards variable. The results, summarized in

Table 22, show a significant difference in the lecture and flipped sections. The overall mean decreased from pre-test to post-test in both groups, which indicates that the students felt the goals and standards were less clear as the semester progressed.

Table 22. *Goals and Standards Variable*

Variable: Goals and Standards	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-.24*	3.121	36	.004	.585
Pre-Test	37	3.87	.50					
Post-Test	37	3.63	.21					
Flipped				-.45*	4.342	37	.000	.720
Pre-Test	38	4.07	.60					
Post-Test	38	3.61	.42					

*A negative number indicates a decrease from the pre-test to post-test score

A paired samples *t*-test was conducted to examine the within group differences of the lecture and flipped groups assessment scale. The results, summarized in Table 23, show no significant differences from pre-test to post-test for the lecture or flipped sections.

Table 23. *Assessment Variable*

Variable: Assessment	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-.21*	1.419	36	.164	
Pre-Test	37	2.99	.82					
Post-Test	37	2.78	.83					
Flipped				-.13*	0.965	37	.341	
Pre-Test	38	2.77	.81					
Post-Test	38	2.64	.59					

*A negative number indicates a decrease from the pre-test to post-test score

A paired samples *t*-test was conducted to examine the within group mean differences of the workload variable. The results, summarized in Table 24, show no significant differences from pretest to posttest for the lecture or flipped sections.

Table 24. *Workload Variable*

Variable: Workload	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				-.16*	1.508	36	.140	
Pre-Test	37	2.51	.54					
Post-Test	37	2.35	.56					
Flipped				-.08*	0.673	37	.505	
Pre-Test	38	2.30	.64					
Post-Test	38	2.22	.60					

*A negative number indicates a decrease from the pre-test to post-test score

A paired samples *t*-test was run to examine the within group differences of the lecture and flipped groups skills variable. The results, summarized in Table 25, show a significant difference in the lecture group, with the overall mean increasing from pre-test to post-test, indicating that the students perceived their skills in problem solving, planning, and working within a group, improved as the semester progressed.

Table 25. *Skills Variable*

Variable: Skills	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture				.20	-2.245	36	.031	-.368
Pre-Test	37	3.56	.48					
Post-Test	37	3.76	.53					
Flipped				.07	-.750	37	.458	
Pre-Test	38	3.50	.68					
Post-Test	38	3.57	.73					

Group Differences Results for the CES

CES Results. To begin the between groups analysis (lecture versus flipped), a delta (Δ) value was calculated for the pre-test to post-test score for the lecture and flipped groups, creating a new variable.

X_1=pretest scores

X_2=posttest scores

D (Δ) =X_2-X_1

(e.g. Lecture X_1 – Lecture X_2 = (Δ) D)

The difference score was then used to determine if between group differences existed between the lecture and flipped section for the CES overall score and five scales.

An independent samples *t*-test was conducted to determine if differences in mean scores on the CES existed between the lecture and flipped groups. Table 26 shows a comparison between the lecture and flipped group for the overall score and five scales. The results show there is not a significant difference between the lecture and flipped groups delta scores for overall course satisfaction, teaching, goals and standards, assessment, workload, and skills.

Table 26. *Group Differences for the Course Evaluation Survey*

Variable	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Overall Course Satisfaction				.24	-1.175	73	.244	
Lecture	37	.35	.79					
Flipped	38	.11	1.01					
Teaching				.14	-.95	73	.346	
Lecture	37	.36	.54					
Flipped	38	.22	.67					
Goals and Standards				.22	-1.67	73	.100	

Table 26. cont.

Variable	N	*M*	SD	*M*diff	*T*	*df*	*p*	*d*
Lecture	37	-.24	.47					
Flipped	38	-.46	.65					
Assessment				.07	.389	73	.698	
Lecture	37	-.20	.87					
Flipped	38	-.13	.81					
Workload				.09	.591	73	.557	
Lecture	37	-.16	.65					
Flipped	38	-.07	.66					
Skills				.14	-1.156	73	.251	
Lecture	37	.20	.55					
Flipped	38	.06	.50					

Research Question 3: Do students in a flipped learning course perform better academically than students in a lecture course?

Block Exam Analysis

Before analysis of the block exams and final exam started, the students GPA was tested to determine if differences existed between the groups. In addition, a brief explanation of how the exam was designed is provided, followed by the statistical results for exam 1, exam 2, and the final exam.

GPA. To determine if GPA differences exited between the lecture and flipped groups, an independent samples *t*-test was conducted prior to analyzing the test scores statistically. Table 27 shows the results were not significant, indicating that the groups have similar GPAs. Regardless, GPA will be used as a covariate on all analysis in this section.

Table 27. *Results of GPA Analysis*

	N	*M*	SD	*M*diff	*T*	*df*	*p*
GPA				.03	-.161	79	.872
Lecture	38	3.32	.69				
Flipped	43	3.35	.86				

Exam Design. The exams used in this course were designed to measure student performance in four areas: their overall score, their knowledge level, their comprehension level, and their application level. Overall score is a traditional way to measure academic performance; however, to examine performance at a more granular level, the tests are designed based on the first three levels of learning in Bloom's Taxonomy. Guidance on constructing test questions based on Bloom Taxonomy was provided by a paper published by Allen and Tanner (2002). Due to this course being a 200 level university course, levels above application (analysis, synthesis, and evaluation) were not measured.

Block 1 Exam. A multivariate analysis of covariance (MANCOVA), that controlled for GPA, was used to determine if mean differences existed between the lecture and flipped sections on the Block 1 Exam. No statistically significant differences were found in the students academic performance based on a participants' grouping (lecture or flipped), $F(4, 75) = 2.48$, $p > .05$, partial $\eta^2 = .158$ (Table 28).

Table 28. *Block 1 Exam Results*

Block 1 Exam	N	*M*	SD	*M*diff
Overall Score				4.68
Lecture	38	86.21	7.17	
Flipped	43	81.53	9.41	
Knowledge Score				.61
Lecture	38	12.03	1.15	

Table 28. cont.

Block 1 Exam	N	*M*	SD	*M*diff
Flipped	43	11.42	1.65	
Comprehension				.35
Lecture	38	10.84	1.42	
Flipped	43	10.49	1.87	
Application				.39
Lecture	38	11.47	1.18	
Flipped	43	10.58	1.84	

Block 2 Exam. A multivariate analysis of covariance (MANCOVA), which controlled for GPA, was used to determine if mean differences existed between the lecture and flipped sections on the Block 2 Exam. No statistically significant difference was found in academic performance on the Block 2 Exam based on a participants grouping (lecture or flipped), $F (4, 75) = .632$, $p > .05$, partial $\eta^2 = .033$ (Table 29).

Table 29. *Block 2 Exam Results*

Block 2 Exam	N	*M*	SD	*M*diff
Overall Score				1.27
Lecture	38	82.03	8.096	
Flipped	43	80.76	11.163	
Knowledge Score				.20
Lecture	38	11.87	1.19	
Flipped	43	11.67	1.39	
Comprehension				.39
Lecture	38	10.92	1.76	
Flipped	43	10.53	2.06	
Application				-.15
Lecture	38	9.92	1.38	
Flipped	43	10.07	1.84	

Final Exam. A multivariate analysis of covariance (MANCOVA), that controlled for GPA, was used to determine if mean differences existed between the lecture and flipped sections on the Final Exam. No statistically significant difference was found in academic performance on the Final Exam based on a participant's grouping (lecture or flipped), $F(4, 75) = .632$, $p > .05$, partial $\eta^2 = .033$ (Figure 30).

Figure 30. *Final Exam Results*

Final Exam	N	*M*	SD	*M*diff
Overall Score				1.67
Lecture	38	90.00	6.51	
Flipped	43	88.33	8.31	
Knowledge Score				-.16
Lecture	38	19.00	1.34	
Flipped	43	19.16	1.48	
Comprehension				.92
Lecture	38	13.18	1.43	
Flipped	43	12.26	1.92	
Application				.15
Lecture	38	12.82	1.59	
Flipped	43	12.67	1.87	

Student Comments on Flipped Learning

Positive Comments. Students were asked a simple open ended question on the week 15 CES: what are some good things about the course? Several comments centered on how much the flipped format promoted discussion, increased collaboration, the ability to ask frequent questions, and that they generally were more engaged:

I like the set up of the class. Help to keep student engage.

I loved the flipped setting. It was always great to be able to collaborate in groups and share ideas. It was also nice to be able to clear up misunderstanding by talking about what each of us had learned. Additionally the "ask a question" lecture style was very helpful to me since it answered my questions and sometimes questions I didn't even know I had.

Overall, I enjoyed the course. To be honest, staying motivated to actually watch the videos during breaks was difficult, but I think the lecture videos was a really good idea. This way, we could have discussions about the material in class and work on things we didn't understand. I really enjoyed the flipped course method!

I thought the class periods were very informative, I liked that students got direct feedback to questions the didn't understand from the lectures. I also thought that working through the problems and situations as a group at a table was beneficial to my learning. We got to work in groups which has helped me get a better understanding of the information when I don't understand the teacher.

The overall materiel was very interesting. I liked being able to review specific case studies to be able to match it to the information that we were learning. I also liked that everything was available online. If I missed class for some reason, I didn't feel like I missed a bunch because I could view the lesson online.

The emphasis on group work and discussion, the new classroom format. / The WSQ, although it seemed like busy work at times really does help understanding of the material.

It was very easy to ask questions. Any time i needed help I could just ask the teacher because of how the discussion orientated the class was.

I think that this course was a great change. i think that the lecturing is forcing students to memorize and forget when we should be applying these things. i think that this course was very good at showing the students the power that they have in a situation. assertive statements are a huge thing that i think to many do not have a good grasp of.

The flipped classroom environment made us more engaged and made us apply our short learned knowledge as opposed to sitting through a lecture.

I really liked the flipped classroom setting. I absolutely hate lectures and would rather be hands on learning. I think the video lectures outside of class were nice because I could watch them on my own time.

I really enjoyed the open atmosphere in the class and the fact that you could ask anything. I enjoyed doing the homework outside of class and then discussing it in class, I feel like that really had a positive impact on retention.

The teaching method in the way that the lectures would be entirely online and the whole class as one would come to discuss the lectures in class. The muddy points helped make misunderstandings clear and really helped in the note taking process.

I liked the group aspect of interacting with the content of the course and not just sitting in front of a lecture. The two hours of class definitely seemed to go by relatively quickly.

The conversational feel of the lectures both online and in class are great for developing ideas and comprehending things discussed. The active recall of information using the whiteboards as a group are effective in assisting the processing of information learned. / The WSQ sheets help to extract the key information and perspective from the video lectures.

Negative Comments: On the week fifteen CES survey students were asked a simple open ended question: what are some things you dislike about the course? While students in general had positive feedback (based on CES and qualitative responses), several identified and spoke to some areas of concern:

Several negative comments spoke to the frequency (interval) of the class and how it may have affected their retention:

I would prefer to have one lesson for each lecture rather than long lecture with two lessons.

Only once a week will be too easy for students lose track and memory about what we learned last week. If can change this class to half semester and maybe 2 days a week it will be better for student.

That it is once a week on Fridays, i feel that i missed some important things due to friday holidays.

It is only once a week, by the time I get to the next class a week later, I have already forgotten some of the things from the previous week.

The uncertainty of my grade. Only having it once per week makes it harder to retain the information.

The students made several comments regarding the difficulties they faced with the size and layout of the room:

The room was OK. I really had to move around to face the teacher.

The size of the room. I feel the same class structure on a smaller scale would work better for myself. / The videos are very in depth but I find them harder to pay attention to than a traditional lecture.

I felt like the class was too separated. The room was really big, and the tables felt really spaced out. Also, When ever we had to talk to the class, we had to spend a lot of time trying to pass around the microphone, which took up class time. Last thing was that because we were all sitting in different directions (unlike a lecture hall where you maintain constant eye contact with the professor), I didn't feel as focused as I wouldve like to. I sometimes found myself going online when there was a lot of downtime (which also falls back on the trouble with the microphones), instead of focusing on the discussions. I think just over all, the class just needs to be streamlined so that there is less down time.

A few participants commented that they did not like the flipped format, mainly because they preferred the lecture format, or felt it was difficult to prepare for exams:

Honestly, I wasn't a huge fan of the flipped classroom style. I think because I am so used to lecture style classes, I have learned to learn in a specific way from those courses, and this course changed that. I was able to do as well as I wanted to(hopefully) however, so I think the class style works.

I did not like that there was not much help when it came to test preparedness. All we were given was packets that we were supposed to gain all of our knowledge from. There was nothing available to actually practice and apply the knowledge that we had. Having quizzes was helpful, but did not really help apply what we learned. It just tested our knowledge.

Summary

In Chapter IV, three research questions were addressed, which looked at critical thinking disposition, student perceptions, and academic performance. The results addressed the within group differences (e.g, lecture pre-test to lecture post-test), and the between group differences (e.g, lecture versus flipped). Provided in Chapter V is a detailed discussion of the results, implications for practice, and future research.

CHAPTER V

DISCUSSION

Provided in Chapter V is an overview of the results in relation to the studies theoretical framework, literature review, and the researchers observations'. This study set out to answer three research questions: does flipped learning change a student's critical thinking disposition?; do students in a flipped learning classroom outperform traditional students academically?; and do their perception change over the course of a 16 week semester?

Data for this study was collected in two sections of a 200 level aviation courses a large upper mid-western university using the California Critical Thinking Disposition Inventory (CCTDI), the Course Evaluation Survey (CES), and course exams. A total of 109 students started the study, with 81 completing the study. The theoretical framework that grounded this study was based on *The Learning Cycles,* created by Robert Karplus (Karplus, 1980).

This chapter is organized by the research questions, with each section including notable findings and discussion. The chapter and study are summarized with limitations and a short conclusion that outlines future research and recommendations to faculty and administrators.

Research Questions

Research Question 1: Does flipped learning change students critical thinking disposition?

Findings and Conclusions. This part of the study was designed to test within group findings, and also between-group findings (against a control group). Overall, the results on the CCTDI were limited in drawing significant conclusions; nonetheless, these results provided a baseline of where the students currently were, and the areas in which they needed improvement.

Two findings on the CCTDI are noteworthy, the significant results on the openmindednesss variable (with and between groups were significant), and the low pre-test and post-test scores on the truth-seeking variable. Overall, only two subscales fell below the CCTDI numerical "positive" score range: truth-seeking (pre-test and post-test) and systematicity (post-test only).

Openmindedness in the flipped group was found to be statistically significant when tested within groups, with an increase in the mean from pre-test (*M*=39.44) to post-test (*M*=40.64), an increase of 1.2 over the course of the semester. The pre-test score fell within the inconsistent/ambivalent range, while the post-test score was in the positive range. Theses scores mean that over the course of the semester, students in the flipped classroom had an inconsistent openness regarding others' views and opinions. By the end of the semester, they had a consistent, positive view of other opinions and views.

To substantiate this finding, the results were compared to the control group (lecture section), and found to be significant, with the mean in the flipped section increasing by 2.01 more than the lecture section from pre-test to post-test. The effect size was calculated using Cohen's d (d=.51), indicating a medium effect. This finding also validated the within group finding, indicating that flipped learning had a significant positive effect on openmindedness in critical thinking disposition over the course of the 16 week semester.

Students in both groups scored in the inconsistent/ambivalent range (30-39) on the pre and post-test for truthseeking. This range indicates that students were inconsistent in their attitude toward seeking the truth; however, scores in this range are the most likely to increase into the positive range with a specific educational training program (Insight Assessment, 2016). Also, truthseeking was also the lowest subscore of the seven measured. A number of studies in

the literature reviewed substantiate this finding (Colucciello, 1997; Giancarlo & Facione, 2001; Ip WY et al., 2000; Kawashima & Petrini, 2004; Tiwari A, Avery A, & Lai P, 2003), indicating that students showed an ambivalent attitude toward truthseeking. The theory is that when students are trying to understand new knowledge, and if understanding is challenging, they will accommodate to assimilate the information, which creates bias (Giancarlo & Facione, 2001). This study showed that truthseeking will continue to be a difficult skill to cultivate in students' critical thinking disposition, even when more active learning strategies are employed.

Discussion. The findings of this study on the CCTDI provided insight into three areas: 1) that this group of students had high critical thinking dispositions (pre-test scores); 2) flipped learning cultivate and promote openmindedness; and 3) truthseeking contiunues to be a difficult skill to improve. Taken together, what do these findings this mean?

If students score high on the pre-test, it can be difficult to detect changes over a short period, specifically with smaller sample sizes. In terms of this study, the students scored high in all of the subcategories, except truth-seeking. Faculty and researchers would benefit from using the pre-test to pinpoint curriculum that would cultivate skills that the students scored low on, in this case, truth-seeking. Lessons within the curriculum might address human bias, and ways to account for it, hopefully improving critical thinking disposition. Students admitted to a large university likely will have high pre-test scores, because they have demonstrated a certain degree of aptitude and critical thinking to be accepted into such an institution.

The significant openmindedness finding provided some insight into the positive aspects that flipped learning has on critical thinking disposition. Lessons in the flipped classroom centered on students discussing the material with group members (i.e., peer instruction) (Lasry, Mazur, & Watkins, 2008) which exposed students to a significant number of other viewpoints

over the course of the semester. In contrast to a traditional lecture class (which exposed students primarily to the teachers views), a collaborative, active learning setting, promoted students openmindedness.

Another area of concern was the low truthseeking scores, and while other studies substantiate this finding, faculty might focus curriculum on helping to cultivate higher truthseeking scores by educating students about bias. Completely removing bias from human decision making is likely impossible; however, teaching approaches and curriculum may provide students an opportunity to increase their awareness (metacognition), ultimately improving their truthseeking scores. The national data discussed in Chapter II (i.e, American Associations of Colleges and Universities, 2015) showed that employers are asking for students who are critical thinkers, individuals who can ask the hard questions in the search for knowledge and truth. A high truthseeking score would indicate they have this skill, yet the scores in this study and other studies are low, indicating a need to focus on growing this skill.

Research Question 2: Do students' perceptions of flipped learning change during the semester?

This part of the study was designed to test within group differences, and between-group differences in students' perceptions as the semester progressed. The results of the CES showed that the students in the lecture section had higher overall course satisfaction and a significant increase in perceived skills over the semester, and both groups rated teaching and goals significantly higher on the post-test. No significance was found on the between groups analysis to substantiate the within groups findings.

Findings and Conclusion. Overall course satisfaction increased significantly from pre-test (M=3.95) to post-test (M=4.14) in the lecture group, indicating that students enjoyed the

class more as the semester progressed. Also, scoring on the teaching scale significantly increased in the lecture group from pre-test (M=3.79) to post-test (M=4.14). The combination of these two significant results may indicate that the faculty member teaching the course had the largest impact on the students' overall course satisfaction in the lecture group; the literature validates this finding and claim, as a high score on the teaching scale has the highest correlation with overall course satisfaction (CES, 1992). Faculty in a lecture setting are at the center of the classroom, making it logical that they will have a significant impact on course satisfaction. On the other hand, faculty in a flipped classroom are not the focal point, which may account for a slightly lower satisfaction score.

Discussion. While finding that the students had a higher overall satisfaction in the lecture group, and not in the flipped group, may be somewhat surprising; a possible explanation will be proposed. The lecture groups participants had a higher level of satisfaction overall and in the teaching variable also. In the flipped learning environment, the faculty member is, as Burgman (2006) states "a guide by the side rather than a sage on the stage" (n.p). When compared to lecture, this means that the faculty role is limited, being the source of less satisfaction. Another issue that may have affected the lower satisfaction scores in the flipped section is that only 5 of the 43 participants indicated they had previously taken a flipped course. A small number of studies that measured students' perceptions longitudinally (Day & Foley, 2006; Mason, Shuman, & Cook, 2013) found that there was some resistance to the flipped format, specifically at the start of the semester. Students who are thrust into a flipped style active learning classroom, where the instructor takes a smaller role, may feel some uneasiness, which may decrease over the semester, nonetheless, it may not be enough time for a complete adjustment. It is worth noting that the pre-test score for the lecture section and the flipped

section were high M=3.95 and M=3.92 respectively, which indicates that the students generally "agreed" with the statement "Overall, I was satisfied with the quality of this course."

Research Question 3: Do students in a flipped learning course perform better academically than students in a lecture course?

This part of the study was designed to test if students performed better academically in the flipped group versus the lecture group. No statistical significance was found between groups on their overall scores, their knowledge level, their comprehension level, or their application level.

Findings and Conclusions. Although the results were not significant, there maybe two explanations for why the flipped group failed to outperform the lecture group academically: intervals and the students lack experience with the flipped format. The concept of spaced learning (intervals) is important to understanding the results of this study, specifically on this question regarding academics. Time and frequency of the class meetings, which is dictated by a multitude of factors, can significantly impact learning. This class is a two credit course, which means the class usually meets two times per week for one hour; however, due to scheduling issues in the SCALE-UP classroom, the flipped section needed to be scheduled one time per week for two hours. On the surface, this scheduling difference seems like a minor detail. Nonetheless, the researcher believes that this variable had a significant impact on the academic results of this study.

Discussion. Why does the learning interval matter so much? The lessons in the flipped classroom, within each block of learning, are designed to build on each other, meaning the students need to master the current knowledge and retain it to be successful for the next lesson because they will be actively using the material in class. At one point in the semester, due to the

holiday schedule, the class did not meet for three weeks; however, the time allotted in class also prevented a significant amount of review in-class. Qualitative comments from students in the flipped class regarding this issue follow:

> *Only once a week will be too easy for students lose track and memory about what we learned last week. If can change this class to half semester and maybe 2 days a week it will be better for student.*
>
> *It is only once a week, by the time I get to the next class a week later, I have already forgotten some of the things from the previous week.*
>
> *The uncertainty of my grade. Only having it once per week makes it harder to retain the information.*

The flipped learning model requires the students to be more self-directed, meaning the burden to motivate themselves to study and review the course material falls primarily in their hands. Having to be more self-directed, coupled with a class that meets only once a week, required internal motivation skills some students may not have had, as this comment suggests:

> *It is harder to motivate myself outside of class, so while watching the video lectures i would often get side tracked and wouldnt fully understand what was being discused. I would also like to see the slide in the video lectures available for use so we are able to go back and look at deffinitions and theroies with out having to rewatch the videos.*

The qualitative comments showed that students struggled with the class only meeting once per week, and that they found staying motivated in the flipped format difficult. A large body of research, summarized in Thalheimer (2006) *Spacing Learning Events Over Time: What the Research Says,* covers spaced learning in detail; and while outside the scope of this study, this research should be applied to the flipped learning model.

Another issue was that the majority of students were experiencing the flipped learning teaching design for the first time (87 percent), which may have caused frustration and anxiety. The literature speaks to some frustration students feel with the flipped classroom (i.e, Day &

Foley, 2006), along with the qualitative comments of this study. Student comfort level in the classroom is essential to their success, and being in a large active learning space for the first time may have impacted their learning. The students made several negative comments regarding the class; following is an example:

> *I felt like the class was too separated. The room was really big, and the tables felt really spaced out. Also, When ever we had to talk to the class, we had to spend a lot of time trying to pass around the microphone, which took up class time. Last thing was that because we were all sitting in different directions (unlike a lecture hall where you maintain constant eye contact with the professor), I didn't feel as focused as I wouldve like to. I sometimes found myself going online when there was a lot of downtime (which also falls back on the trouble with the microphones), instead of focusing on the discussions. I think just over all, the class just needs to be streamlined so that there is less down time.*

Acclimating to a new space can take away from the educational experience. Conducting the research, this phenomenon was observed first hand in the classroom. The students had a hard time tracking me if I was speaking, and they genuinely disliked that the size of the classroom required the use of microphones to ensure others could hear them when they were speaking.

Limitations of the Study

There were several limitations to this study: the length of the study, the small sample size and limited population, the boredom effect on post-test results, and the naturalistic setting of the classroom. Each limitation has unique characteristics and subsequently impacts the generalizability of the study in a different way.

The first limitation was the length of the longitudinal study with regard to specifically utilizing the California Critical Thinking Disposition Inventory (CCTDI). Differences on an affective perception test are difficult to detect over such a short period, and any significant results should be used in a supportive manner, not in a causal way. Future longitudinal research should be longer to prevent significant results from being overshadowed by measurement error.

An additional limitation of this study was the small sample size and limited population. The study started with over fifty participants in each group; however, related mainly to attendance requirements and some additional factors, the number who completed the study were reduced to the high thirties for both groups, reducing the power of the study to detect small changes. In this case, the sample was a convenience sample, and the researcher had little control over the size of the sample.

Boredom effect can be a limitation in any longitudinal study. Students may become bored and disinterested after completing the pre-test, performing differently on the post-test (Field, 2013). Another issue that may have contributed to the boredom effect is that this study took place in the Spring semester, which leads to summer break. Students are burned out and ready for summer break, and the idea of more surveys, on top of their final exams, may have contributed to the boredom effect. Extra credit was offered to students who completed the study, which may have provided some motivation, mitigating the boredom effect.

The final and most important limitation to any study in the classroom is the naturalistic setting. A naturalistic study allows the researcher to observe the participants in their environment, undisturbed; while there are benefits, it creates variables the researcher has difficulty controlling.

Conclusions and Recommendations

To conclude this study, it is necessary to provide a brief summary of the findings along with recommendations for practice and future research. The study found that the flipped learning format increased a students' openmindedness, and that students in both sections showed significant increases in satisfaction with teaching and goals.

Connecting the Pieces

While the lack of significance seems disappointing, the results are still interesting and provide some insight into the benefits and drawbacks of flipped learning not previously discussed in the literature. As implementation of flipped learning increases across the nation, more students will be exposed to the format, which will likely reduce their apprehension and anxiety regarding this teaching approach. The lecture is still a popular form of delivering information to people, and will continue to be (e.g, the success of TED talks). The benefits of flipped learning will be realized when an accurate understanding of how lecture provides the foundational learning, and active learning (like flipped) gives students the opportunity to use it. The lecture is not dead, it just needs to be utilized correctly by educators.

Recommendations for Faculty. The findings of this study make it difficult to recommend the flipped learning approach; nonetheless, that is what the researcher is doing. Teaching and learning can be nuanced, and faculty need to understand two things: when to use a teaching method and how to use it. Stating flipped learning does not lead to better educational outcomes, based solely on this study, is to miss the point. As past research has found, lecture works well for facts (e.g, Bligh, 1998), and active learning provides students an opportunity to work with the information at a higher level (e.g, Freeman et al., 2014). National data suggest educators are not helping cultivate students' critical thinking skills and dispositions needed to be successful in a 21st-century workforce, and universities need to ensure their curriculum and teaching approaches cultivate critical thinking.

The results of this study demonstrate how nuanced learning in the classroom can be, and how important it is for faculty to understand their roles based on their teaching approach and the learning material being presented the students. Faculty should think about their teaching

approach as a spectrum, and if lecture and flipped learning are on opposites sides of the spectrum, an understanding of the how and when to move along this spectrum is essential to effective teaching, and ultimately student learning. A one size fits all approach has no place in education, leaving the educator to determine the best approach to be used based on the course material, resources, and the students.

Faculty need to continue to pursue teaching methods, such as flipped learning, which places learning into the hands of the students. Our current predominant educational approach, lecturing, provides the greatest benefit to the teacher, not to the students. As faculty, we should seek out teaching methods that empirically benefit the students, not just the faculty member. Faculty should continue to use the flipped learning approach with the understanding that the lecture is still a valuable piece of the education process; nonetheless, when and how it is used is the most important part.

Recommendations for Research. There are three recommendations for future research on critical thinking disposition and flipped learning. The first is with regard to critical thinking disposition, the second relates to intervals (spaced learning), and the third is student perceptions.

The first recommendation regarding longitudinal critical thinking disposition is with regard to the timeline, and the need for an increase if the research is going to be conducted with highly educated individuals. While survey data would suggest higher education is falling short on producing critical thinkers (skills and dispositions), the students in this study, and those attending colleges and universities across the US, are intelligent, capable individuals (i.e, they got into college). There is a high likelihood that their pre-test scores will be high, making it difficult to see a statistically significant increase in a short period, especially with small sample sizes.

The second recommendation calls for ensuring that any research design involving flipped learning that has a control group should carefully consider intervals (frequency and duration of classes). The researcher feels that offering the class once per week had an adverse impact on student learning in the flipped section. A large number of qualitative comments made by students confirmed this finding.

The third recommendation is that researchers need to consider creating and validating an instrument that specifically addresses students' perceptions in flipped classrooms. Scales that address room layout, the recorded lecture videos, peer to peer tutoring, and self-directed learning would be beneficial to examine the positive and negatives aspects of the flipped classroom at a more granular level, likely providing even more research ideas.

APPENDICES

Appendix A
Data Codebook

Critical Thinking Disposition in Flipped Classroom Codebook

Demographic Questions

Name	Item
gender	What is your gender? (1) Male (2) Female
age	What is your age in years? (1) Text box
ethnic	I am… (1) White/Caucasian (2) African American/Black (3) American Indian (4) Mexican American/Chicano (5) Asian American/Asian (6) Puerto Rican American (7) Other (please list) (8) Open box
year	What is your current status as a university student? (1) Freshman (2) Sophomore (3) Junior (4) Senior (5) Other
certificates	Please select the flight certificate and ratings you currently hold? (1) Student Pilot (2) Private Pilot (3) Private Pilot with Instrument Rating (4) Commercial Pilot with Instrument Rating (5) Certified Flight Instructor (6) Certified Flight Instructor Instrument (7) I do not hold any certificate or ratings
hours	What is your total flight hours? (1) Text box
prevflip	Besides this course, have you taken any other courses that have been flipped? (1) No, this is the first flipped course I have taken (2) Yes, I have taken other flipped courses in college and/or high school

The Course Evaluation Survey (CES).

Instructions to participants:

The Course Evaluation Survey (CES) is designed to assess your perceptions of the human factors course you are currently enrolled in. This survey is voluntary. If you have any questions or concerns, please contact Mark Dusenbury at 701.777.5495 or dusenbur@aero.und.edu.

Note: measures and scales are tested at two points during the semester. The first measurement ends with a one and the second measurement ends with a two.

Example:

Time 1: teach_1_1
Time 2: teach_1_2

Teaching Scale

Name	Item
teach_1_1	The faculty and staff of this course motivated me to do my best work.
teach_2_1	The faculty and staff put a lot of time into commenting on my work.
teach_3_1	The faculty and staff made a real effort to understand difficulties I might be having in this course.
teach_4_1	The faculty and staff normally gave me helpful feedback on how it was going.
teach_5_1	The faculty and staff were good at explaining things.
teach_6_1	The faculty and staff worked hard to make course material interesting.

Goals and Standards

Name	Item
goals_1_1	It was always easy to know the standard of work expected.
goals_2_1	I usually had a clear idea of where I was going and what was expected in this course.
goals_3_1	It was often hard to discover what was expected of me in this course.
goals_4_1	The faculty and staff made it clear from the start what they expected of me academically.

Assessment

Name	Item

assessment_1_1	To do well in this course all you really needed was a good memory.
assessment_2_1	The faculty and staff seemed more interested in testing what I had memorized.
assessment_3_1	Faculty and staff asked me questions just about facts.

Workload Scale

workload_1_1	The workload was too heavy.
workload_2_1	I was generally given enough time to understand the things I had to learn.
workload_3_1	There was a lot of pressure on me to do well in this course.
workload_4_1	The sheer volume of work in this course couldn't all be thoroughly comprehended.

Skills Scale

skills_1_1	The course developed my problem solving skills.
skills_2_1	The course sharpened my analytic skills.
skills_3_1	The course helped me develop my ability to work as a team member.
skills_4_1	As a result of my course, I feel confident about tackling human factors
skills_5_1	The course improved my skills in written communication.
skills_6_1	This course helped me to develop the ability to plan my own work.

Overall Satisfaction

satisfaction_1_1	Overall, I was satisfied with the quality of this course.

California Critical Thinking Disposition Inventory (CCTDI)
Instructions to participants:

The California Critical Thinking Disposition Inventory (CCTDI) is designed to assess your critical thinking disposition. This survey is voluntary. If you have any questions or concerns, please contact Mark Dusenbury at 701.777.5495 or dusenbur@aero.und.edu.

overall	Overall score on the CCTDI
truthseeking_1	Score on truthseeking scale.
open_mindedness_1	Score on open-mindedness scale.
analyticity_1	Score on analyticity scale.
systematicity_1	Score on systematicity scale.

confidence in reasoning_1	Score on confidence in reasoning scale.
Inquisitiveness_1	Score on inquisitiveness scale.
maturity_of_judgement_1	Score on maturity of judgement scale.

Appendix B
Institutional Review Board Research Approval

UNIVERSITY OF NORTH DAKOTA

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DIVISION OF RESEARCH & ECONOMIC DEVELOPMENT

Institutional Review Board
Twamley Hall, Room 106
264 Centennial Dr Stop 7134
Grand Forks, ND 58202-7134
Phone: 701.777.4279
Fax: 701.777.6708

December 28, 2015

Principal Investigator:	Mark Dusenbury
Project Title:	Does Flipping the Classroom Have an Effect on Critical Thinking Disposition
IRB Project Number:	IRB-201512-187
Project Review Level:	Expedited 7
Date of IRB Approval:	12/23/2015
Expiration Date of This Approval:	12/22/2016
Consent Form Approval Date:	12/23/2015

The application form and all included documentation for the above-referenced project have been reviewed and approved via the procedures of the University of North Dakota Institutional Review Board.

Attached is your original consent form that has been stamped with the UND IRB approval and expiration dates. Please maintain this original on file. ***You must use this original, stamped consent form to make copies for participant enrollment. No other consent form should be used.*** It must be signed by each participant prior to initiation of any research procedures. In addition, each participant must be given a copy of the consent form.

Prior to implementation, submit any changes to or departures from the protocol or consent form to the IRB for approval. No changes to approved research may take place without prior IRB approval.

You have approval for this project through the above-listed expiration date. When this research is completed, please submit a termination form to the IRB. If the research will last longer than one year, an annual review and progress report must be submitted to the IRB prior to the submission deadline to ensure adequate time for IRB review.

The forms to assist you in filing your project termination, annual review and progress report, adverse event/unanticipated problem, protocol change, etc. may be accessed on the IRB website: http://und.edu/research/resources/human-subjects/

Sincerely,

Michelle L. Bowles, M.P.A., CIP
IRB Coordinator

MLB/sb
Enclosures

Cc: Chair, Aviation

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