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Transformation of the Dental Faculty to Promote Changes in Dental Educaiton

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A dissertation submitted to the faculty of
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Doctor of Philosophy

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ABSTRACT

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This work introduces a series of papers developed to explore the case for change in dental education. Three issues facing dental education are (a) the challenging financial environment of higher education, making dental schools very expensive and tuition-intensive for universities to operate and producing high debt levels for students, which limits access to education and restricts career choices; (b) the profession's apparent loss of vision for taking care of the oral health needs of all components of society and the resultant potential for marginalization of dentistry as a specialized health care service available only to the affluent; and (c) the nature of dental school education itself, which has been described as convoluted, expensive, and often deeply dissatisfying to its students. The theoretical rational for this work is that developing dental faculty from solely clinicians to academicians will allow for the curricular change so needed in dental education. Furthermore, it is curricular change that can lead to changes in the oral health profession.

My work first explores the scientific nature of research into dental education to determine its ability to advance the profession. This study found that while there has been a small increase in the amount of rigorous dental education research in the past 10 years, it remains a small percentage of the overall research completed in the field. We then researched the effect of pedagogical training for dental clinicians and discovered predictors for those faculty members more likely to alter their methods to be more student centered. Our narrative research into faculty resistors (those unwilling to change) allowed us to identify themes that can alter our approach to future faculty development. And finally, we researched the effect of modern pedagogy on a course in the dental school curriculum. This research allowed us to justify curricular changes that improve efficiency and student performance.

Keywords: dental education, faculty development, education research, dental curriculum

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CHAPTER 1

How "Scientific" Is Dental Education Research?

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ABSTRACT

In 2006, The American Dental Education Association Commission on Change and Innovation (ADEA CCI) published the first of a series of white papers calling for systematic change in dental education. The passive, teacher-centered instruction in the classroom was highlighted as one of the reasons change was needed. Specifically, it was noted that the dental education environment had yet to capitalize on research-based alternatives that have long been shown, via proper research design, to improve student learning. Certainly, the teaching within the health sciences should be faithful to the true nature of science by adopting proven methods, scrutinizing our own processes, and then adding to the scientific discussion to which that method was associated.

In this study we review the literature published since these analyses were made by the CCI white papers to discover the reaction within our profession. We seek to discover the amount of research within dental education focused on the scientific endeavor to advance understanding. Does our educational research seek to empirically test the theories and practices of teaching and then gather data that indicates what works? Does our educational research embrace the standards of experimental design established within science?

We surveyed 720 research articles published in the *Journal of Dental Education* in 2008–2009, 2013–2014, and 2017–2018 to discover the extent to which they embraced scientific standards. The surveys were done using a filter created by the authors that categorized each article according its level of rigorous, theory-driven hypothesis testing. Different cohorts of time were introduced to analyze trends over time beginning with this initial call for change by the CCI. While the overall number of articles studying student learning remained at 40% over time,

the percentage of these articles classified as "experimental" has shown slight improvement within that same period of time.

The purpose of this paper is to systematically categorize and describe a sampling of articles published by the JDE as a means to understand the rigorous nature of educational research since the CCI white papers. In evaluating the scientific nature of our research we hope to predict the likelihood of these methods being embraced in the classroom.

INTRODUCTION

In September of 2006 the JDE published, "The Case for Change in Dental Education," which introduced a series of white papers published by the ADEA CCI (Pyle et al., 2006). This publication emphasized that the dental educational model was "dissatisfying to consumers," due to "passive learning environments [that] fail to challenge students' ability to grow intellectually and to become critical thinkers and lifelong learners." (p. 922) At that time, it was shown that our dental curriculum had yet to adopt research-based educational theories. In their words:

> These approaches to learning have yet to be institutionalized in dental education, perhaps because changing the usual way we design and deliver curricula causes anxiety, and perhaps because doing what we know is easy. If students are to move from memorization of facts to an integrated experiential approach, then current educational programs will need to reassess their goals, workload, relevancy, efficiency, and effectiveness. To move away from an educational environment that rewards memorization and survival game strategies, students must have time to reflect and think about their learning (Pyle et al., 2006, p. 922).

The authors emphasized the need to adopt *theory-driven* educational methods, which would demand a different approach to traditional educational formats (Bruner, 1966, p. 100). Even though our knowledge base regarding how people learn has increased dramatically in the past century, far too little of that knowledge is promoting significant change within our dental educational system.

Notwithstanding the relative infancy of educational research within the scientific endeavor, its current distinction is well documented in other disciplines (Bain, 2004; Kolb, 1984). A historical account of discipline-based educational research (DBER) shows physics as an early

adopter of implementing change as a consequence of educational research as early as the 1960s. Soon thereafter, chemistry (1980s), engineering (1990s), biology (2000), and astronomy (2000) were also adopting evidence-based methods in the classroom (National Research Council, 2012). These methods exist as a result of scientific inquiry that was held to the same standard as any other discipline within the scientific endeavor. Within dental education, systematic investigation of student learning gains would have us striving toward universal goals, meeting rigorous standards, formulating complex questions, and understanding when intellectual progress surrounding existing theory has been accomplished.

In meeting these standards, the enterprise of science believes that science can be self-correcting and highly adaptive over time. It seems self-evident that these techniques can also be focused on developing a deep understanding of how people learn, resulting in improved teaching and learning within dental education. Observable and measurable student outcomes are critical to demonstrating success in teaching and creating learning environments that support progress for each student, thereby improving the entirety of dental education through scholarship (Handelsman, Miller, & Pfund, 2004).

Within the growing field of DBER, this approach to educational research creates scientific teaching, offering a natural structure for teaching that parallels our approach to research. Scientific teaching adopts methods whose effectiveness has been established by theory-driven research; yet, some academics are openly skeptical, if not hostile, toward the results of education research:

> to illustrate the status frequently given to [educational research], it is unlikely that any of us would ever stand up in a research colloquium talk about general relativity and insist that some GR data could not possibly be valid because of our anecdotal experience that

time seems to accelerate as we mature. Not only would such behavior be considered poor form, but the perpetrator would most likely be censured for asserting an opinion that is entirely "unscientific" in nature. (Slater, 2010)

We do disservice to our discipline and our students by reducing science education to a spontaneous, sometimes haphazard, process of delivering information with no attention to evidence either from the published literature or from our students about the validity of our delivery methods. Teaching habits based on evidence rather than experience alone can aid veteran instructors in enriching and reinvigorating their teaching with proven methods rather than allowing a last-minute, somewhat-random approach to designing classes. Building a framework according to the principles of scientific teaching requires forethought, planning, and time.

If research is done following standard methods agreed upon by the larger community, both science and education research can have the same level of objectivity. Dental curricula are dynamic and in a constant state of change. With the ever-constant reminder of the need to improve our educational models, it is important to remember that curriculum and course revisions should be evidence based and supported by research studies, not simply by anecdotal testimony.

Based on the theoretical framework outlined in the initial white paper published by ADEA CCI, we submit an approach via literature review to consider to what extent the dental profession has sought to advance instructional methods and embrace research-based educational theories. Just how successful has dental education research been in building on, refining, or replacing theoretical frameworks to guide teaching? Has our research been theory driven? Are we collectively advancing and testing theories using sound experimental design that explain how schools, dental educators, and students interact so that students learn science and develop

scientific literacy? Or, has our research remained largely descriptive? To answer these questions, we have conducted a thorough literature review within the *Journal of Dental Education*.

METHODS

Using the online archives, we had full access to all articles published by the J*ournal of Dental Education* (JDE). Within Microsoft Excel, we created our own database for articles published within three different time periods: 2008–2019, 2013–2014, and 2017–2018 (the first white paper calling for theoretical frameworks to guide instruction were highlighted in the September 2006 edition of the JDE). The objective of our database was to create a systematic filtering system to categorize articles according to the research goals, research methods, and the subsequent findings as reported in the article.

Our aim was to identify educational research designed and carried out using the rigorous scientific standards inherent within other disciplines. Additionally, we sought to quantify relative trends in the amount of this research since 2007. Our methodology for filtering articles is illustrated in Figure 1.1 and described below.
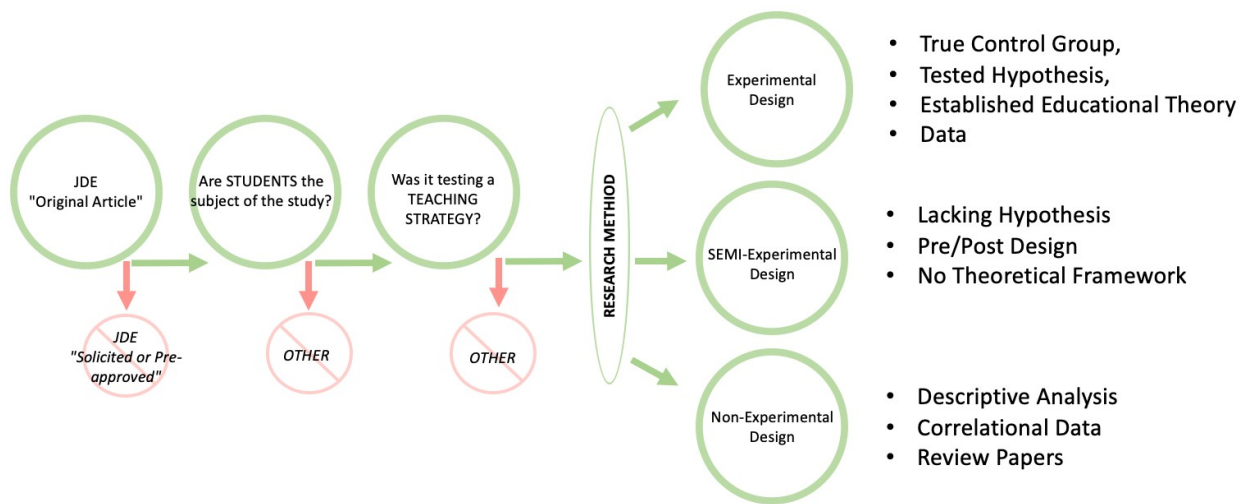
Figure 1.1. Database filtering methodology

Our first filter was whether or not the article was an original article. According to the JDE submission requirements, "Original Articles should report the results of hypothesis-based research studies and may be either qualitative, quantitative or of a mixed methods nature. Manuscripts must address how the findings advance our understanding of the questions asked in the study and make a novel contribution to the literature" (ADEA, 2018). All non-original articles are submitted upon request of the editor. Non-original articles are those solicited or pre-approved by the editor. Examples of non-original articles are letters to the editor, guest editorials, perspectives, brief communications, and point/counterpoint. Therefore, these were the first articles eliminated from our study, as they were not hypothesis based.

Our second filter asked the question, "Are students the subject of the study?" Examples of articles excluded with this filter included those evaluating faculty shortages, faculty development, administrative policy, patient demographics, and more. Thus, only articles whose focus was on dental students were included for additional review.

Our third filter asked, "Is this article testing a teaching strategy?" Articles excluded with this filter included ones whose foci were things such as admissions criteria, student demographics, student perceptions of their education, profiles of the millennial generation, and student stress. Thus, only articles whose focus was the testing of a specific teaching strategy were included for further analysis.

At this point in our review we divided the remaining 720 articles according to the research methods described in the articles. Specifically, we sought to identify research that was designed and carried out using the rigorous scientific standards inherent within other disciplines. We divided the remaining articles into three categories that will be described below.

Non-Experimental

In this case, by *experimental* we mean that the study manipulated a variable and utilized some type of control. This is not to say that "experimental" can't be interpreted in many ways. But, for the purpose of our description, we are limiting its use to that described above. Thus, articles within the non-experimental category were found to be descriptive in nature, reports of correlational data, or systematic reviews of the literature. In that no variable was manipulated and subsequently tested we described them as non-experimental. Example descriptions of a sampling of these publications included:

- Setting up an interdisciplinary course in information resources and evidence-based dentistry

- Assessing changes in dental students' attitudes and beliefs about community service

- A literature review of cultural competency education in the health

- A position paper regarding IPE

- A paper exploring the usefulness of ePortfolios as a learning tool for dental students

- A paper exploring the value of Grand Rounds

- A description of the development and implementation of a flipped classroom

- Describing the correlations and predictive value of knowledge-based and clinical assessments.

Special care is taken here to note the importance of this type of research within the realm of science. Descriptive studies have an important role in educational research and have greatly increased our knowledge about what happens in schools. This research involves gathering data that describe events and then organizes, tabulates, depicts, and describes the data collection (Glass & Hopkins, 1984).

However, results from these studies do not generally support or refute causal mechanisms (i.e., test causal hypotheses). Nevertheless, data can emerge following creative exploration, and these studies can serve to organize findings in order to fit them with explanations which can *then* lead us to test or validate those explanations (Krathwohl, 1993).

Semi-Experimental

Semi-Experimental articles are articles that possess many aspects of true experimental design, but that don't meet the full criteria. Thus, articles were placed in this category if they (a) manipulated a variable but failed to clearly state a hypothesis (i.e., they lacked clarity or repeatability); (b) used a one-group pretest-posttest design in which the control and test groups were the same group, and measurable changes indicated that something worked, but not that it worked better than something else (i.e., they lacked internal validity); or (c) failed to tie the methodology to an accepted theoretical framework such that the findings remained contextualized and weren't broadly applicable (i.e., they lacked predictive value). Once again, we take special care to recognize that these types of studies are still valuable in advancing our understanding in the field and may in fact lead to subsequent inferential analyses.

Experimental

As an indicator of our success in dental education to adopt instructional methods based on theory established by rigorous hypothesis testing, we looked to the JDE as the most relevant source of published educational research. These are articles with clearly stated and testable hypotheses, true control group designs (i.e., independent-samples designs), and references to established educational theory to back their hypotheses. Example descriptions of these included the following:

- Looking at the effectiveness of an electronic histology tutorial as a mode of learning

- Audience response systems in a preclinical operative dentistry course

- Long-term retention of clinical communication skills learned in a second-year standardized patient simulation

- The effect of virtual technology on students' learning and skills related to porcelain-fused-to-metal (PFM) crown preparation.

- Communication skills training for dental students

RESULTS

Our first analysis was regarding the total number of articles devoted to student learning. For the 720 total articles reviewed, Table 1.1 and Figure 1.2 show the trends over time of the distribution of articles by subject. Looking at articles testing a teaching strategy for students, between 2008–2009 and 2013–2014 the percentage dropped significantly, from 38.5% to 25.5% ($X^2 = 26.10$, $p > 0.001$). The percentage of these articles then rose again significantly in 2017–2018 ($X^2 = 38.40$, $p > 0.001$). Of note, between the groups 2008–2009 and 2017–2018 there was no significant change ($X^2 = 1.57$, $p = 0.457$).

Distribution of JDE articles by subject
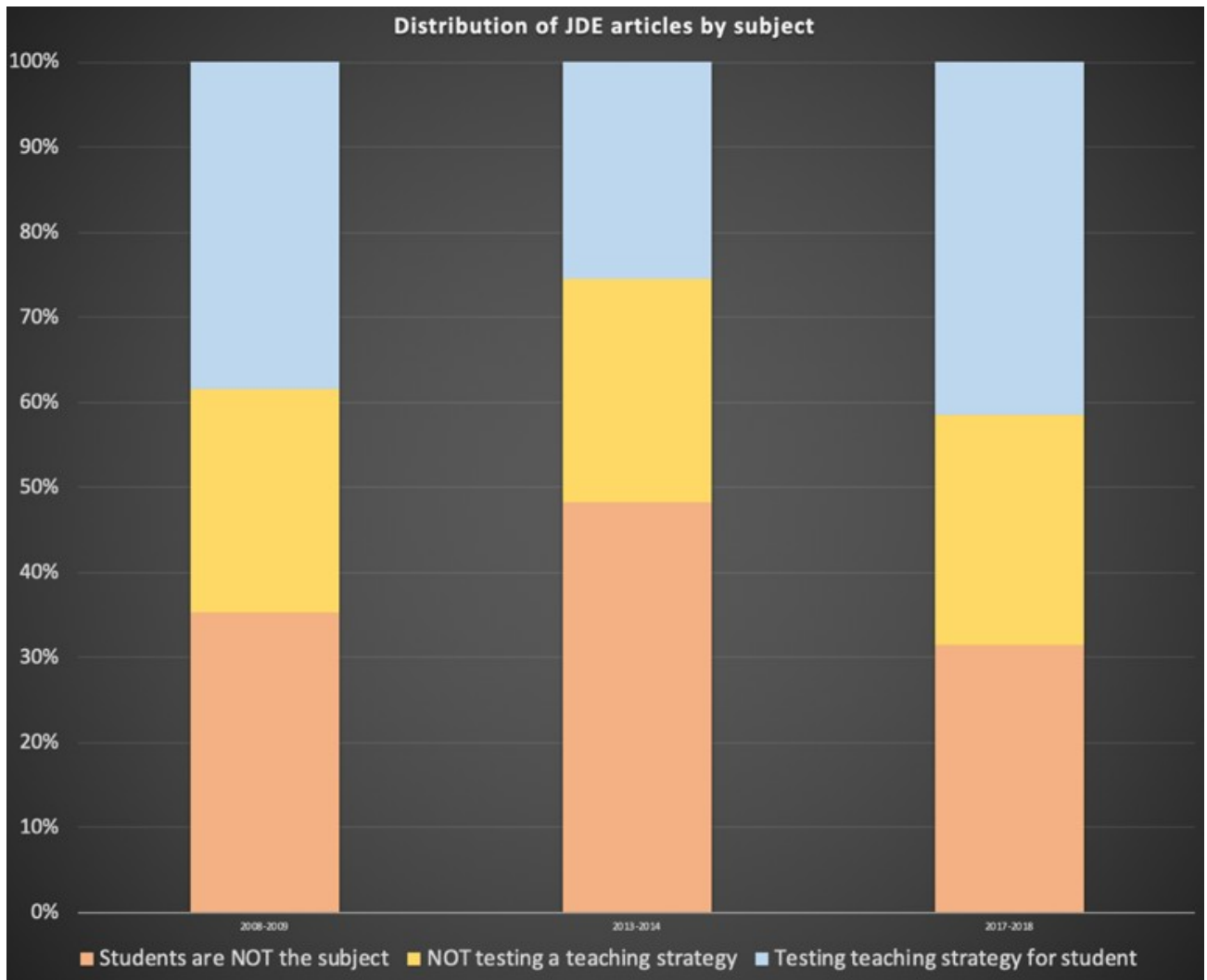
Figure 1.2. While there was a significant decrease in the percentage of articles devoted to student learning, these numbers rebounded to around 40%.

Table 1.1

Distribution of JDE Articles by Subject

	Students are NOT the subject	NOT testing a teaching strategy	Testing teaching strategy for student
2008–2009	35.3%	26.2%	38.5%
2013–2014	48.3%	26.2%	25.5%
2017–2018	31.6%	27.0%	41.4%

In addition, we looked for trends within those articles referencing student learning (Table 1.2 and Figure 1.3). Non-experimental descriptive articles encompassed 70.8% of the original articles in 2008–2009, 61.6% in 2013–2014, and 67.3% in 2017–2018. Articles categorized as semi-experimental began at 25.0% in the years 2008–2009, increased to 27.4% in the years 2013–2014, and then decreased to 24.5% in the years 2017–2018.

And finally, in the years 2008–2009, 4.2% of the original articles published in the *Journal of Dental Education* were classified as experimental in their testing of a teaching strategy for students. This category of these articles increased to 11.0% in the years 2013–2014 ($X^2 = 8.97$, $p = 0.011$), and then decreased to 8.2% for the years 2017–2018 ($X^2 = 1.55$, $p = 0.462$). Of note, while the overall percentage between 2008–2009 and 2017–2018 did increase, it was not significant ($X^2 = 8.97$, $p = 0.147$).

Distribution of JDE articles referencing a teaching strategy for students

- ■ Experimental Design (True Control Group, Tested Hypothesis, Referencing Established Educational Theory)
- ■ Semi-Experimental (Lacking Hypothesis, Pre/Post Design, No Theoretical Framework)
- ■ Nonexperimental Design (Descriptive Analysis, Correlational Data, Review Paper)
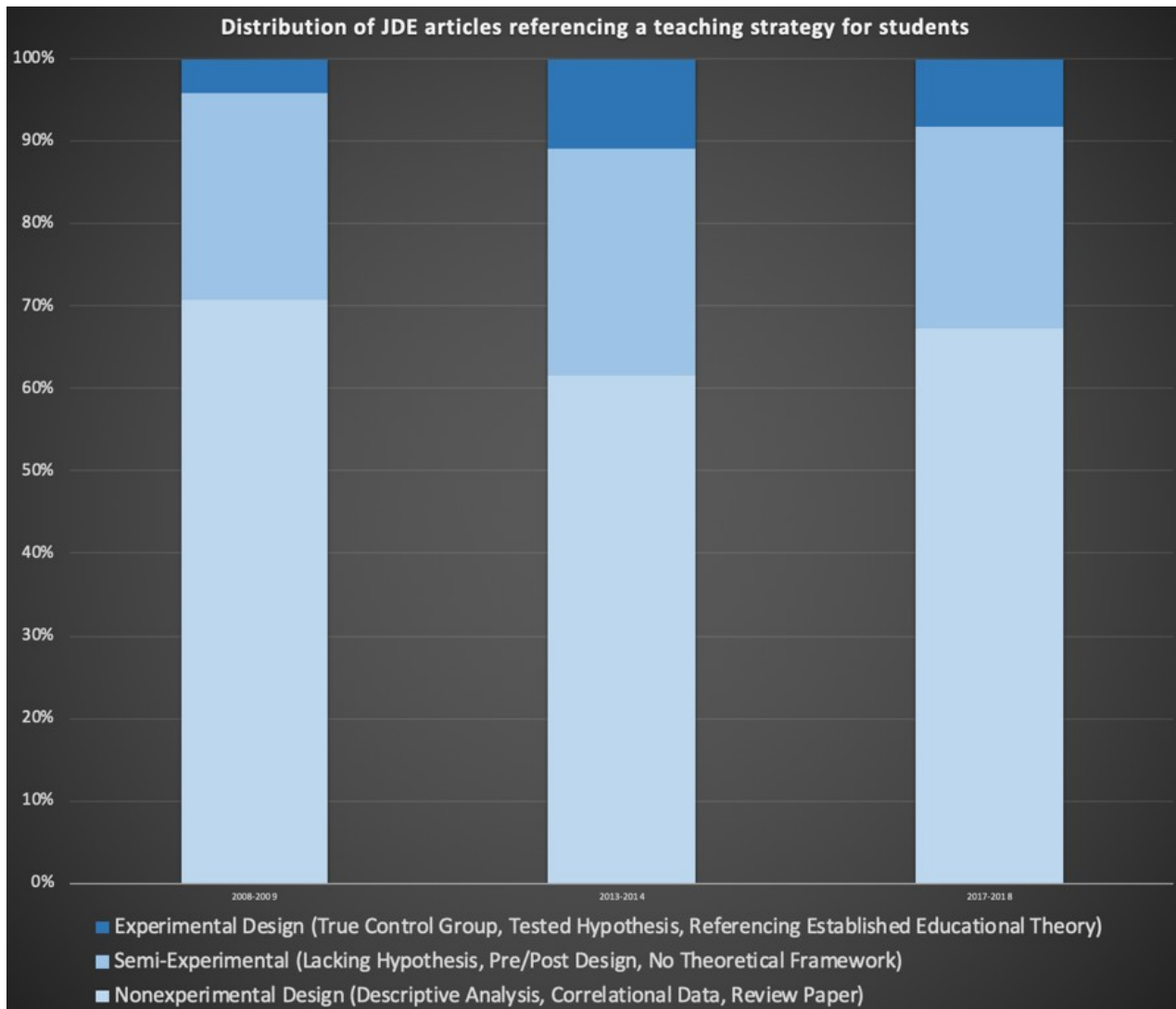
Figure 1.3. Distribution of the articles published in the *Journal of Dental Education* referencing a teaching strategy. For this study, these articles were analyzed and categorized as non-experimental, semi-experimental, and experimental. Experimental articles have remained less than 10% of the total number of articles devoted to student learning.

Table 1.2

Distribution of Articles Published in JDE Referencing a Teaching Strategy

	Nonexperimental design (descriptive analysis, correlational data, review paper)	**Semi-experimental** (lacking hypothesis, pre/post design, no theoretical framework)	**Experimental design** (true control group, tested hypothesis, referencing established educational theory)
2008–2009	70.8%	25.0%	4.2%
2013–2014	61.6%	27.4%	11.0%
2017–2018	67.3%	24.5%	8.2%

In summary, while the total number of articles devoted to student learning has rebounded to 40% of all original articles, a small percentage of them are classified as experimental. Overall, experimental design is still mainly non-experimental. There has been an increase since 2007–2008, but this increase is not statistically significant.

DISCUSSION

It is imperative that the drive for innovation and creativity serves as a catalyst for initiating new models of dental education. Indeed, generating and analyzing the evidence that results from exploring new models of education that is aimed at minimizing curricular inefficiencies, alleviating the burden of inadequate care in underserved communities, or exploring how interprofessional practice can change the practice environment are as important as the science conducted by the bench researcher or clinical investigator. It is essential, and should be self-evident, that dental schools need to determine where they can best contribute not only to the research mission of their own university but also to the advancement of the dental profession (Polverini, 2017b).

The question at hand is not whether research and discovery are important to the future of the profession, but, rather, will dental schools be the place where the new knowledge is created? Research, whether in the clinical sciences or in the discovery of improved instructional models, is a standard dating to the early 1900s with the Gies report, which stated, "Teaching and research in dental schools should be as effectual as the best in the university and the status of the dental faculty should be raised accordingly." If dental schools are unwilling or unable to meet this responsibility, the profession they serve runs the risk of reverting to its apprentice-based origins and mortgaging its future to other health care disciplines that may not have the best interests of the dental profession in mind (Polverini P. J., 2017).

Scientific research, whether in education, physics, chemistry, engineering, or biology, is a continual process with an interaction among methods, theories, and findings. It builds understandings in the form of theories that can be tested. The purpose of research in science education is the same as that in other fields of science, i.e., to advance the conceptual systems that have been developed to explain events in the universe about us. Though science education is in its intellectual infancy in the scientific enterprise, there is reason to believe that advances in this field can eventually have as far-reaching consequences as have developments in atomic theory and cell theory (Novak, 1963).

To "advance the conceptual systems which have been developed" suggests we adhere to established theory when designing our research questions. Science generates cumulative knowledge by building on, refining, and occasionally replacing, theoretical understanding. (Lawson, 2010) In doing so, the significance of the work can be justified.

CONCLUSION

How successful has dental education research been in advancing and testing theories using sound experimental design that explains how students learn and thrive as health care providers? Based on the present results, we can conclude that dental education research has adopted more experimental methodologies over the past ten years, although the relative amount of this research is very little when compared to the whole of dental education research. This is not a trivial matter. Without explicitly stated predictions, researchers may struggle to know if their theories and/or hypotheses were supported of contradicted. Further, when authors do not explicitly identify and label these key elements, readers are less likely to understand what was done and what it means for both theory and practice. In fairness, however, this assessment is based on reported research, not on individual interviews with authors of that research. The implication is that becoming more aware of how to test hypotheses and theories will collectively improve the way dental educators conceive of and carry out this research in the classroom.

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CHAPTER 2

The Role of Dental Faculty: Clinician or Academician?

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ABSTRACT

There is a need within the dental education curriculum to adopt theory-driven educational methods, which demand a different approach to traditional educational formats. The overarching goal of research-based education formats is to achieve a more student-centered learning environment through active and collaborative learning. There is substantial variation in the way that dental educators conceive of teaching and learning and how these approaches relate to student learning. Provision of faculty development related to teaching and assessment strategies is widely perceived to be the essential ingredient in efforts to introduce new curricular approaches and modify the educational environment in academic dentistry. Understanding these concerns motivated the creation of a faculty development workshop series. We hypothesized that detailed and directed pedagogical training would enable faculty to transition their courses into a more student-centered environment. The workshops were focused on the development of student-centered teaching skills and assessment of curricula that employ evidence-based pedagogical strategies to increase student scientific reasoning skills and deep conceptual understanding. In order to test our hypothesis, we analyzed COPUS data before and after treatment. We then used multiple regression analysis, which determined that the magnitude of change toward student-centered teaching could be predicted based on experience as an educator and the student-centered mentality score from the pre-interview. For every single-category increase in experience (e.g., going from new educator to mid-level educator, or from mid-level to experienced educator), the normalized change toward student-centered-teaching *decreased* by 17.5%. Furthermore, for every one-point gain in student-centered mentality score, the normalized change toward student-centered teaching *increased* by 8.4%. Our research indicated that those with a more student-centered mentality were more likely to embrace student-centered

practices in their courses. In addition, we found that faculty with more experience were less likely to change their teaching practices after pedagogical training. These findings can guide our recruitment processes in discovering potential faculty whose mentality lends itself toward student-centered teaching, as well as focus our faculty development efforts to highlight student-centered practices.

INTRODUCTION

In September of 2006, the *Journal of Dental Education* published, "The Case for Change in Dental Education," which introduced a series of white papers published by the American Dental Education Association (ADEA) Commission on Change and Innovation (CCI). This publication emphasized that the dental educational model was "dissatisfying to consumers," due to "passive learning environments [that] fail to challenge students' ability to grow intellectually and to become critical thinkers and lifelong learners" (Pyle et al., 2006, p. 922). At that time, it was shown that our dental curriculum had yet to adopt methodologies based upon long established educational theories. In their words

> these approaches to learning have yet to be institutionalized in dental education, perhaps because changing the usual way we design and deliver curricula causes anxiety, and perhaps because doing what we know is easy. If students are to move from memorization of facts to an integrated experiential approach, then current educational programs will need to reassess their goals, workload, relevancy, efficiency, and effectiveness. To move away from an educational environment that rewards memorization and survival game strategies, students must have time to reflect and think about their learning. (Pyle et al., 2006, p. 922).

The authors emphasized the need to adopt theory-driven educational methods, which would surely "demand a different approach to traditional educational formats" (Bruner, 1966, p. 100). Even though our knowledge base regarding how people learn has increased dramatically in the past century, far too little of that knowledge is promoting significant change within our dental educational system.

The overarching goal of research-based education formats is to achieve a more student-centered learning environment through active and collaborative learning. This pedagogical model emphasizes *student-centered teaching*, in which the learner rather than the teacher is the focus. The role of instructors is changed from deliverer of content to coach, mentor, and guide during purposeful and interactive classroom activities (Barr & Tagg, 1995; Weimer, 2003).

Teacher-Centered Instruction

There is substantial variation in the way that dental educators conceive of teaching and learning and how these approaches relate to student learning. Traditionally, teaching is often viewed as the transmission of information instead of obtaining conceptual change. Studies consistently report that between 73–83% of teachers choose the lecture format as their main instructional method (Salter, Pang, & Sharma, 2009). In the lecture class model, class time is generally instructor directed for 90–100% of the time. However, a great deal of research shows that the lecture is little more than an information transaction and is not an effective way to create deep learning or creative thinking (Weigel, 2002).

Certainly, a well-presented lecture may be a means to deliver essential information or ideas quickly and efficiently. However, in that lectures are a monologue, they do not allow students to engage in the type of conversations needed to lead to deep understanding of the course material. Research suggests that as an instructional method, this approach does not result

in deep learning of the content presented (Biggs, 1978; Entwistle & Ramsden, 1983; Marton & Saljo, 1976). Furthermore, the deep learning that is possible from classroom dialogue is required to attain higher quality learning outcomes such as the synthesis of new ideas and the transfer of learning to new applications (Trigwell & Prosser, 1991).

In a traditional view, the instructor prepares for giving a lecture by preparing the content he or she will present. This teacher-centered approach emphasizes, "What do I (the teacher) need to do to prepare this information?" In a student-centered approach the emphasis changes so that the instructor now asks, "What does the student need to do to learn this material?" The role of teacher shifts from preparing content to preparing tasks; these tasks are designed to subsequently engage the students with content resources and sometimes challenge beliefs that can provoke conceptual changes in the students (Pedersen, & Liu, 2003; Prosser & Trigwell, 2001; Trigwell, Prosser, & Waterhouse, 1999).

Student-Centered Instruction

In the student-centered classroom the role of the teacher changes from the "sage on the stage" to the "guide on the side" who views the students not as empty vessels to be filled with knowledge but as seekers to be guided along their intellectual developmental journey (Wright, 2011). Students learn by doing, and so involving them in the learning activities promotes learning. This learning model encourages students to learn from each other through increased peer-to-peer interactions and team learning in a collaborative learning environment (Illeris, 2003; Bandura, 1986). For example, students become part of the presentation and learn from each other when they respond to instructor invitations to give examples, applications, and summaries, and they experience learning when they take part in problem-solving sessions. In-class activities that involve students provide faculty with opportunities to help guide them in clarifying their

understanding and in assimilating the subject matter in meaningful ways. For effective learning it is desirable to move toward a model in which students are actively engaged in the learning process (Baxter & Gray, 2001). At the same time, students are held responsible for their own learning in an active and engaged learning process to promote critical thinking skills through pre- and post-intervention assessments and opportunities for peer assessments (Park & Howell, 2015).

Faculty Development

Provision of faculty development related to teaching and assessment strategies is widely perceived to be the essential ingredient in efforts to introduce new curricular approaches and modify the educational environment in academic dentistry. Indeed, analyses of the outcomes of efforts to revise curricula in the health professions have identified the availability and effectiveness of faculty development as one of the key predictors of the success or failure of reform initiatives (Licari, 2007).

It has been reported that increasing demand to incorporate new pedagogies into teaching places burdens on faculty and institutional systems as they attempt to stay current (Wright, 2011). Lack of time to restructure coursework and/or lack of follow-up in professional development aimed at helping faculty develop pedagogically sound components to a course redesign may partially explain why there is such a strong tendency in many institutions for faculty to limit their use of student-centered approaches and instead merely present content (Salter et al. 2009).

Understanding these concerns motivated the creation of a faculty development workshop series. The majority of the faculty in our study had come from private clinical practice. While a dental clinician's expertise is valued and necessary in the context of the dental school

environment, this skillset is limiting as it pertains to an ability to teach. There is a need to transform faculty from clinicians to academicians.

We hypothesized that detailed and directed pedagogical training would enable faculty to transition their courses into a more student-centered environment. The workshop series was taught using a student-centered approach, allowing faculty members to take an active role in their own learning of the material. The content of the course guided faculty in redesigning their own courses to give students and instructors new roles in which students would be more actively engaged and not just be lectured to by the instructors. In planning classroom activities, the focus was on identifying the tasks students needed to do in order to learn the material rather than on the tasks teachers needed to do in order to prepare the class presentation. The faculty engaged in dialogue, which had the potential to challenge beliefs and produce conceptual changes. These approaches helped transform many of the classrooms from teacher-centered to student-centered.

METHODS

In order to test our hypothesis, that detailed and directed pedagogical training could cause a change in instructor teaching practice, a series of eight faculty development workshops were scheduled between January 2017 and June 2017. The workshop series was endorsed by the Office of Academic Affairs, who requested that all full-time faculty, adjunct faculty, and hygienists attend all sessions of the series. Clinics were closed for each of the half-day sessions so all faculty could attend. A total of 46 full-time and part-time faculty participated in the faculty development workshop series. Of these, 20 met all the requirements to be included in this study (i.e., attended all eight workshops, taught a didactic course, were willing to be observed teaching their course, were willing to take part in a pre-workshop interview, and had both a pre- and post-workshop observation completed for their course).

The workshops were focused on the development of student-centered teaching skills and assessment of curricula that employ evidence-based pedagogical strategies to increase student scientific reasoning skills and deep conceptual understanding.

Each workshop session was 4 hours in length and was scheduled approximately one month apart. The workshop instructor was an education researcher and faculty development expert from a neighboring university who was hired by Roseman College of Dental Medicine as adjunct faculty specifically for the presentation of this workshop, as well as personal consulting for all faculty. This instructor specialized in the development and assessment of curricula that employ evidenced-based pedagogical strategies to increase student scientific reasoning skills and deep conceptual understanding. Her teaching interests include introductory biology for non-majors, introductory biology for majors, and advanced teaching methods coursework for graduate students.

Each workshop was designed as a 4-hour, interactive, working session so that instructors were actively engaged in the process of change. The topics and objectives are illustrated in Table 2.1.

Table 2.1

Topics Included in Each of the Faculty Development Workshops

Workshop	Topic	Objectives
Workshop 1	Self-reflection	Explore and define the purpose of your course.
Workshop 2	How people learn	Working memory
		Cognitive load
		Equilibration theories

		Conceptual frameworks
		Self-regulation
		Metacognition
Workshop 3	The development of intellect	Piaget
		Vygotsky
		Scientific reasoning
		Constructivism
		Motivation
Workshop 4	Constructivist teaching	Introduction to the learning cycle
		Introduction to other tips of the trade for getting students involved in the learning process
Workshop 5	Redesigning teaching & assessment	How to transform your current curriculum into a constructivist, student-centered format
		Formative and summative assessment strategies
		Testing formats
Workshop 6	Teaching the nature of science & assessing your teaching	Helping students understand the "why" behind the "what"
		Teaching students to think like scientists/clinicians
Workshop 7	Follow-up	Review what has been learned in the workshop and preview upcoming faculty presentation

assignment. Faculty were placed within groups with the following assignment:

- Design a classroom, clinic, or simulated learning session
- Create high-level thinking formative and summative assessments
- Evaluate other faculty presentations and deliver appropriate/effective feedback

Workshop 8	Faculty presentations	As a culminating project, faculty groups presented their classroom, clinic, or simulated learning session to other faculty members. Furthermore, they were graded on their projects by their peers as well as a panel consisting of our dean, the workshop series instructor, and the author.
One-on-one consulting (optional)	Course design	Faculty were allowed to receive one-on-one guidance from the workshop series instructor to transition their own instruction to a more student-centered design.

Note. The workshops were focused on the development of teaching skills and assessment of curricula that employ evidence-based pedagogical strategies to increase student scientific reasoning skills and deep conceptual understanding.

Data Collection

In order to test our hypothesis, we implemented an evaluation plan that included both formative and summative assessment of the process used by the workshop series to achieve its goals of impacting faculty teaching practices.

The evaluation focused on two main outcomes (see Table 2.2): (a) changes in faculty behavior, and (b) Changes in student behavior as a result of changes in the classroom practice. Our research was significantly enhanced with the addition of a team of undergraduate researchers who were able to expand the data collection process. Data sources are described in more detail below.

Table 2.2

Evaluation Questions and Associated Data Sources

Evaluation question	Data sources
(1) To what extent do faculty participants implement student-centered teaching and reflective practice?	(A) Classroom Observation Protocol for Undergraduate STEM (COPUS) (B) Lesson Plan Survey (C) Interviews
(2) What effect does student-centered teaching practices have on student engagement?	(A) COPUS

COPUS: Classroom Observation Protocol for Undergraduate STEM

Upon confirmation of intended participation in this faculty development workshop, observational data was collected from participants' current classes to serve as a baseline for their

teaching practices. We used the Classroom Observation Protocol for Undergraduate STEM (COPUS; Smith, Jones, Gilbert, & Wieman, 2013). The COPUS is an observation protocol that documents classroom behaviors in 2-minute intervals, allowing the observer to characterize the nature of instructor and student behaviors. Thus, COPUS data can be used to evaluate the extent of pedagogical reform and the level of engagement of students in the course. The results can be mapped as a pie chart, allowing for quick visual discrimination between a primarily lecture-based class and a more active-learning format. The results can also be quantified by individual items. Training to use this instrument takes less than two hours.

COPUS data was again collected after the workshop series to determine whether a change in teaching practices occurred.

Lesson Plan Survey

For faculty who planned to participate in the workshop series but were not currently teaching a class (i.e., COPUS data could not be gathered as a pre-test measure), previous lesson plans were surveyed to evaluate the level of student-centered teaching in current coursework. This was used as a proxy for the COPUS data. The lesson plan survey was carried out by members of our research team, all calibrated to facilitate these surveys. Researchers set an appointment to meet with the faculty member for one hour. In addition, faculty were given instruction to specifically prepare for the lesson plan survey. The faculty member was asked to describe in detail how a typical instruction session took place. The faculty provided copies of the PowerPoint presentations, handouts, and/or any other materials used in the instructional period discussed. As that the COPUS protocol documents classroom behaviors in 2-minute intervals, the researchers would guide the faculty through a minute-by-minute analysis of their classroom session. The researcher would then transfer this information to the COPUS database to create the

same quantitative data shown from an actual COPUS in-class observation. (Instructions given to faculty members, as well as a lesson plan calibration guide for researchers, can be found in the appendix to this article).

This method is a possible limitation of our study in that we have found no study to validate this method as an appropriate method to replace the classroom observation protocol. Seven of the 20 subjects in our study were evaluated using this method. We are currently gathering data to understand the limitations of the lesson plan survey when used in proxy of the COPUS.

Faculty Interviews

Interviews were conducted to understand the faculty members' backgrounds with teaching in general and student-centered teaching specifically, as well as their concerns regarding pedagogical change. These interviews were conducted prior to their participation in the faculty development workshop.

All faculty were asked the same questions (see Table 2.3). All interviews were recorded and transcribed according to guidelines established by the IRB. Using transcription notes, a thematic analysis was completed on each of the completed interviews. Before thematic analysis, training was carried out by the author. Each interview was independently evaluated before the team met as a group. Appropriate themes were determined and assigned to thematic categories identified within the analysis.

Table 2.3

Pre-Workshop Interview Questions and Subsequent Categories Discovered During Thematic

Analysis

Question	Thematic categories
How long have you been an educator?	1. New educator (1–4 yrs.) 2. Mid-level educator (5–9 yrs.) 3. Experienced educator (10+ yrs.)
Do you feel there is a need to change the way we deliver content to our students? Why or Why not?	1. Yes 2. No 3. Unsure
Have you ever participated in formal coursework regarding educational theories and practice?	1. Yes 2. No 3. Unsure
What percentage of your in-class delivery of content is active learning?	4. 1–25% 5. 26–50% 6. 51–75% 4. 76–100%
Can you describe your strengths as an educator?	1. Student centered 2. Teacher centered 3. Other

Student

Can you describe your greatest challenges to being an educator?	1. Student centered 2. Teacher centered 3. Other
Please describe a typical instruction environment when you are the instructor (e.g. what is going on, for how much time, when are you talking, when are the students talking, etc.)	1. Student centered 2. Teacher centered 3. Other
As an educator, what do you think your role should be? (In other words, what is your responsibility in the learning process?)	1. Student centered 2. Teacher centered 3. Other
What do you think the student's role as the learner should be (in other words, what is their responsibility in the learning process?)	1. Student centered 2. Teacher centered 3. Other

Note. Five of the interview questions were used to assign a student-centered mentality score for each faculty.

Four of the pre-interview questions provided nominal data, allowing us to group faculty responses into categories. For the question, "How long have you been an educator?" faculty responses were labeled as 1 = new educator (1–4 yrs.), 2 = mid-level educator (5–9 yrs.), or 3 =

experienced educator (10+ yrs.). When asked, "Do you feel there is a need to change the way we deliver content to our students?" faculty responses were simply labeled as 1 = yes, 2 = no, or 3 = unsure. Answers for the question, "Have you ever participated in formal coursework regarding educational theories and practice?" were also labeled as 1 = yes, 2 = no, and 3 = unsure. And finally, for the question, "What percentage of your in-class delivery of content is active learning?" answers were placed into four bins: 1 = 1–25%, 2 = 26–50%, 3 = 51–75%, or 4 = 76–100%.

Five of the pre-interview questions were meant to detect an inherent mentality regarding student-centered teaching. Using thematic analysis, faculty responses for each these five questions were labeled as 1 = student-centered, 2 = teacher-centered, or 3 = other. Descriptions of these questions and themes, with example quotes, are outlined below.

Question: Can you describe your strengths as an educator?

Teacher-centered responses. These answers were categorized as teacher-centered in that the focus of the response was on the instructor and on what the instructor knew about clinical dentistry and practice.

"My training in oral facial pain and oral surgery."

"Practical experience over 25+ years as a dental practitioner."

"Varied background in private practice, military, and different practice variations from solo practice, to group practice, to associateship."

"I was running a dental practice on my own, and just a great variety of dental practice situations."

Student-centered responses. These responses can be differentiated from the teacher-centered responses in that the focus is on the students. In addition, responses indicating a faculty's willingness to learn were categorized as student-centered.

"I think I have the ability to understand where students are coming from, both in how well they understand material as well as [their unique] process of understanding material, I think each person gets a grasp on information differently."

"I try to see how [students] are assimilating information and try to teach it to them in a way that is suited to their strengths and how they are going to learn a topic."

"I like to meet and know everyone individually and help them in different ways because everybody learns in different ways."

"I would say [ability to teach]. I want to get good at being an educator. And yea, I don't know other than that. I want to be good at it, and I recognize that I have a long way to go."

"I am willing to learn, I guess, so I know coming into this as a young educator that I've got a lot to learn. So I guess willingness to learn and adapt is maybe another strength."

Question: Can you describe your greatest challenges to being an educator?

Teacher-centered responses. When the responses indicated fault with the students, and the faculty took no accountability, they were categorized as teacher-centered.

"wish that [students] were more prepared than they are when they begin"

"motivating students"

"trying to do things the way that administrators say they have to be done"

"age difference between myself and [students]"

Student-centered responses. These responses admitted deficiencies within themselves instead of the students. They saw the students as eager and willing and took accountability for what was learned in the classroom. They also indicated a willingness to improve via feedback.

"Teaching novices as an expert and how to individualize in a class of 84 students."

"My lack of formal training."

"Figuring out what I don't know, and the best way for students to learn."

"Oh, everything! From preparing materials, to writing assessments, to grading assessments, to creating learning structures and activities that are engaging to the students, the whole process."

Question: Can you describe a typical instruction environment when you are the instructor (e.g., what is going on, for how much time, when are you talking, when are the students talking, etc.)

Teacher-centered responses. Here were the responses that indicated a more traditional approach to delivering content to students. They often specifically mentioned the length of their lectures and/or power point slides.

"Historically, I've been more of a talker."

"My strengths are clinical . . . and so [classroom instruction] would be lecture step-by-step. And that was just basically traditional because [where I began as an instructor] was done pretty much the same way since it was formed in the late 1800s, and you gave a lecture."

"Well, most of the time I'm doing the talking."

"In the class room, you're trying to get knowledge out quickly to them because you have a limited amount of time to give them everything and so to date, there's probably a lot more talking and power pointing."

Student-centered responses. These instructional periods were described as "no lecture" or "very little lecture." When faculty were able to detail the student interaction involved with problem-based learning and case-based learning in lieu of lecture they were categorized as student centered.

"I like to start class for the first 15–20 minutes with a formative assessment, and then there'd be some discussion, some break out activities for the students, and then another large group discussion."

"Small groups and then activities that get to utilize the principles, and then we come back to have some sort of review activity to see what they all learned, to make sure they all learned the same things."

"I'll usually have some sort of activity whether it's a worksheet to fill out with a group of people or some activity where they can get their hands on it and work with something physical."

Question: As an educator, what do you think your role should be? (In other words, what is your responsibility in the learning process?)

Teacher-centered responses. These responses included comments regarding the amount of time dedicated to the creation of their PowerPoint presentations, awards received as an educator, or their expertise as a teacher. These responses also indicated the importance of their role as the expert, or sage within the classroom.

"To leave them better prepared to provide the services they need to for the rest of their professional lives; that's a big load on my shoulders."

"I'm their principal resource for knowing how to [do a certain dental procedure], and if they leave Roseman without knowing how to do that, I take that very seriously, that I've failed them."

"Right now, I think, you know, my role in the learning process is to put out competent dentists"

"Probably to facilitate students through their requirements . . . and then get them out into the world."

Student-centered responses. Here the responses indicated the importance of creating the appropriate environment for students to learn and emphasized the importance of understanding the students and being a guide for student learning.

"My role is to facilitate an environment where that individual can assimilate that information how they need to. Cause they are going to remember the best if they are learning things how their brain processes things, how they see things."

"I really try to make an environment where I focus on creating an environment where that individual can learn the topic how they need to."

"My responsibility is to create an open environment for students to learn."

"It's to facilitate learning. To be there and to help the students learn is what I would say is, yea, to help them learn, to facilitate their learning, to figure out ways that they can learn better than just sitting in class waiting for somebody to tell them what they should learn."

Question: What do you think the student's role as the learner should be (in other words, what is their responsibility in the learning process?)

Teacher-centered responses. Similar to the question above, these responses indicated the importance of the faculty role as the expert, or sage within the classroom.

"To be there."

"[Students] should be prepared."

"I think their role is to obtain the information."

"They need to participate in self-study and preparation prior to the experiences."

Student-centered responses:. Responses indicated the significance of a student understanding their own method of learning.

"I think [students] have the largest responsibility and that they themselves need to take ownership"

"It's my belief that they need to take a very active role in their own education"

"to spend some time figuring out, 'what is my individual learning process?' And then they come to a learning environment . . . with an open mind and a willingness to engage in that environment"

"I think the bulk of the learning of responsibility falls to the student."

"I can create the environment, but [students] need to be engaged in the learning process."

The Student-Centered Mentality Score

Five of the pre-interview questions described above were meant to detect an inherent mentality regarding student-centered teaching (see Table 2.3). From these questions, we created a student-centered mentality score for each faculty. The score represents the number of responses

by an individual faculty member that were categorized as student centered. If all responses from an individual faculty member were categorized as student centered, they were given a student mentality score of 5. If none of the responses from an individual faculty were categorized as student centered, they were given a student centered mentality score of 0.

RESULTS

In order to test our hypothesis that our intervention could cause change in instructor teaching practice, we analyzed COPUS data before and after treatment (Descriptive data for the 20 faculty are found in Tables 2.4 & 2.5).

Table 2.4

Data Collected From Interview Questions

Variables	Average	Minimum	Maximum	*N*
% time guiding (*before* treatment COPUS)	27.2%	2.0%	56.0%	20
% time guiding (*after* treatment COPUS)	45.7%	2.0%	88.0%	20
% change toward guiding (normalized)	30.4%	-6.5%	72.7%	20
Pre-interview mindset score (see Table 2.5)	2.35	0	5	20

Table 2.5

Data Collected From Interview Questions to Determine Student Mindset Score

Pre-interview question	Thematic categories	Faculty distribution	N
How long have you been an educator?	New educator (1–4 yrs)	11	20
	Mid-level educator (5–9 yrs)	5	
	Experienced educator (10+ yrs)	4	
Have you ever participated in formal coursework regarding educational theories and practice?	Yes	6	20
	No	12	
	Unsure	2	
Did you feel there is a need to change the way we deliver content to our students?	Yes	12	20
	No	5	
	Unsure	3	
What percentage of your in-class delivery of content is active learning?	1–25%	8	20
	26–50%	6	
	51–75%	2	
	76–100%	4	

A chi-square goodness of fit test was conducted to analyze the distribution of behaviors for faculty from their COPUS *before* and COPUS *after* data (see Table 2.6). There were statistically significant changes in distributions for 12 of the 20 faculty members ($p < .05$), all toward more student-centered practices (i.e., more guiding, less presenting).

Table 2.6

Distribution of Behaviors of Faculty Members Before and After COPUS

ID	COPUS before			COPUS after			X^2	df	p
	Guiding	Presenting	Other	Guiding	Presenting	Other			
F_1	38	62	0	78	18	4	132.07	2	<.001**
F_2	7	89	4	4	88	8	4.26	2	0.119
F_3	21	72	7	22	71	7	0.06	2	0.971
F_4	25	75	0	72	17	11	239.56	2	<.001**
F_5	9	91	0	67	30	3	177.24	2	<.001**
F_6	8	92	0	16	77	7	13.92	2	0.001**
F_7	2	94	4	2	90	8	2.18	2	0.337
F_8	56	40	4	88	12	0	41.89	2	<.001**
F_9	54	43	2	87	12	1	11.52	2	0.003*
F_10	49	51	0	70	29	1	23.99	2	<.001**
F_11	42	58	0	80	18	2	108.94	2	<.001**
F_12	27	65	8	77	20	3	142.05	2	<.001**
F_13	44	56	0	60	39	1	12.68	2	0.002*
F_14	21	71	8	35	47	18	23.41	2	<.001**
F_15	30	64	6	41	53	6	5.23	2	0.073

F_16	16	78	6	9	82	9	6.64	2	0.036*
F_17	38	62	0	34	63	3	3.49	2	0.175
F_18	16	79	5	23	73	4	2.87	2	0.238
F_19	31	65	4	40	56	4	3.47	2	0.1763
F_20	10	88	2	9	83	8	4.91	2	0.086

*$p < .05$, **$p < .001$

Note. COPUS values are percentages of the overall recorded behaviors. Other included waiting and administrative tasks.

We then used multiple regression to understand whether a transition to student-centered teaching (%CHANGE_SCT) can be predicted based on experience as an educator, amount of student-centered teaching already integrated, student-centered mentality score from the pre-interview, perceived need of student-centered teaching, and an educator's ability to self-assess their current use of student-centered teaching.

While this model statistically significantly predicted a positive change in a faculty member becoming more student centered through our intervention, $F_{(4, 16)} = 5.825$, $p = .008$, adj. $R^2 = 0.547$, the model did not meet the assumption of multicollinearity as some of the correlations were as high as 0.7. In addition, we recognize the challenge in our relatively small sample size ($N = 20$). With these considerations in mind we ran the model again to include only two predictor variables. In addition to helping us meet our assumptions, limiting our predictor variables allows us to make a more adequate estimation of regression coefficients, standard errors, and confidence intervals by having 10 subjects per predictor variable (Austin & Steyerberg, 2015).

Further analysis of our model indicated a high correlation between the student-centered mentality score, the amount of student-centered teaching already integrated, perceived need of student-centered teaching, and an educator's ability to self-assess their current use of student-centered teaching. Therefore, we limited our predictors to student-centered mentality score from the pre-interview and experience as an educator.

In this subsequent model the magnitude of change toward student-centered teaching (%CHANGE_SCT) can be predicted based on experience as an educator and the student-centered mentality score from the pre-interview. With this model there was no evidence of multicollinearity, as assessed by tolerance values well above 0.1, no studentized deleted residuals greater than ±3 standard deviations, and values for Cook's distance above 1. Also, there was linearity as assessed by partial regression plots and a plot of studentized residuals against the predicted values. There was independence of residuals, as assessed by a Durbin-Watson statistic of .821. There was homoscedasticity, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. The assumption of normality was met, as assessed by a Q-Q Plot. The multiple regression model statistically predicted a change to student-centered teaching and explains 57% of the variance in change, $F(2, 19) = 11.240$, $p < .001$, adj. $R^2 = .569$. Both variables added statistically significantly to the prediction, * $p < .05$. Regression coefficients and standard errors can be found in Table 2.7.

Table 2.7

Summary of Regression Analysis

Variable	*B*	SE$_{ß}$	*B*	*p*
Experience	-17.461	6.084	-.480	.011
SC mindset score	8.399	3.093	.454	.015

Note. B = unstandardized regression coefficient; SE$_{ß}$ = Standard Error of the coefficient; β = standardized coefficient.

For every category increase in experience (e.g., going from new educator to mid-level educator, or from mid-level to experienced educator), the normalized change toward student-centered-teaching *decreased* by 17.5%. Furthermore, for every one-point gain in student-centered mentality score, the normalized change toward student centered teaching *increased* by 8.4%. Figures 2.1 and 2.2 illustrate COPUS scores for different student-centered mindset Scores and experience as an educator.
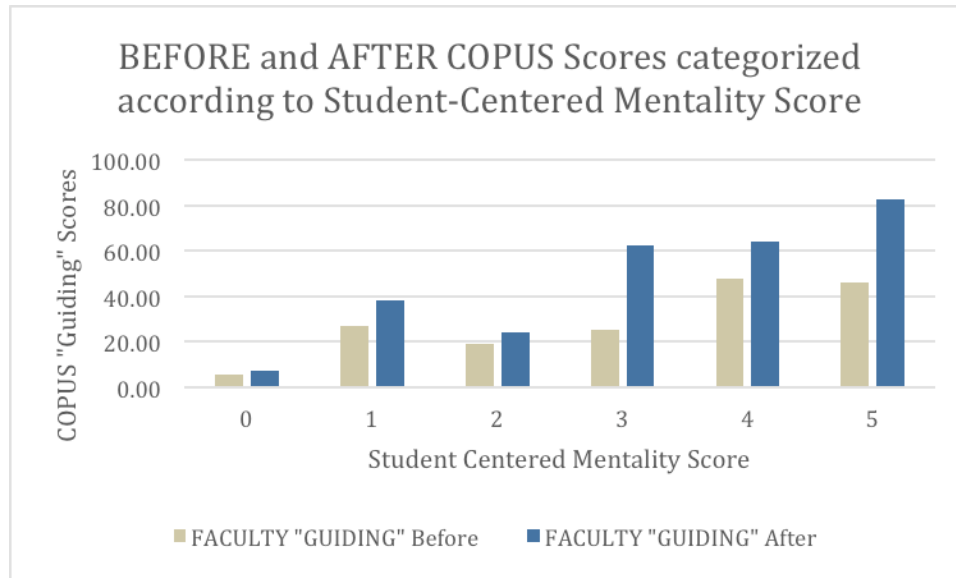
Figure 2.1. For every one-point gain in student-centered mentality score, the normalized change toward student centered teaching *increased* by 8.4%.
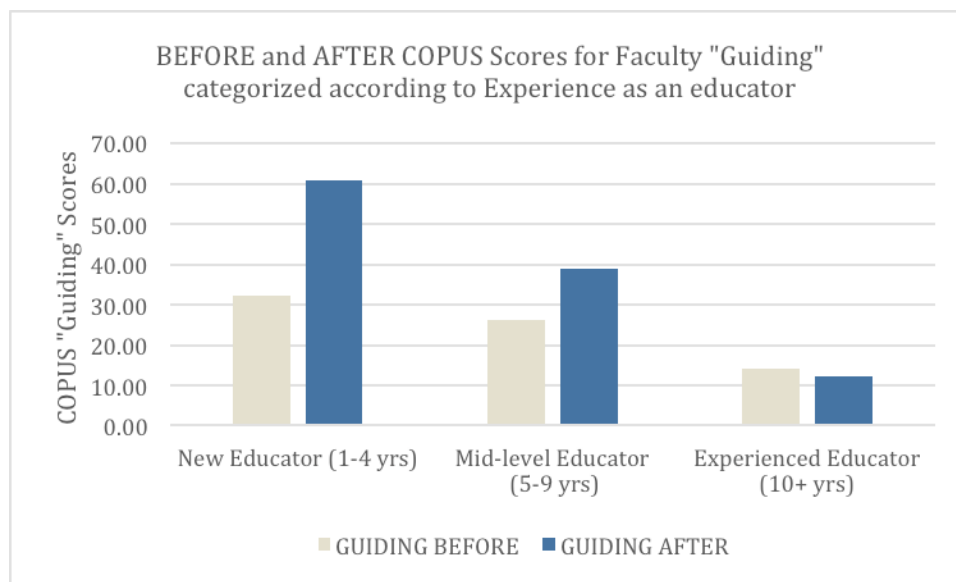

Figure 2.2. For every category increase in experience, the normalized change toward student-centered teaching *decreased* by 17.5%.

DISCUSSION

Our research indicated that detailed and directed pedagogical training could cause a change in instructor teaching practice from teacher-centered to more student-centered methods for many faculty participants. Specifically, the research indicated that those with a more student-centered mentality were more likely to embrace student-centered practices in their courses.

The theory of planned behavior provides a theoretical framework to explain the predictive value of our student-centered mentality score. This theory states that intentions to perform behaviors of different kinds can be predicted with high accuracy from attitudes toward the behavior (Ajzen, 1991).

The interviews conducted prior to the faculty development workshop indicated which faculty members already had positive attitudes toward student-centered teaching practices, quantified using our student-centered mentality score. These positive attitudes were predictive of the teaching behaviors we measured. This motivational factor is consistent with what other research on faculty teaching change has found to be influential (Martin, 2016).

These findings can guide our recruitment processes in discovering potential faculty whose mentality lends itself towards student-centered teaching, as well as focus our faculty development efforts to highlight student-centered practices.

In addition to the predictive value of the student-centered mentality score, we found that faculty with more experience were less likely to change their teaching practices after pedagogical training. This finding is consistent with the research reviewing the literature on the development of pedagogical knowledge for educators (Friedrichsen et al., 2009). Experience alone is not sufficient to learn pedagogical skills (Abell, 2008). Furthermore, strong subject matter knowledge (i.e., dental expertise) does not lead to the development of pedagogical content

knowledge (Lee, Brown, Luft, & Roehrig, 2007), and may even limit a faculty members' ability to understand the novice perspective, as their own expertise has filtered their knowledge of learners, instructional strategies, curriculum, and assessment (Geddis, 1993). These findings are pertinent to dental education, which for decades has adhered to the tradition that clinical competence naturally morphs into competence in the classroom (Hendricson et al., 2017).

While a dental clinician's expertise is valued and necessary in the context of the dental school environment, this skillset is limiting as it pertains to an ability to teach. These findings should hasten our efforts in recruiting faculty in the beginning stages of their career, and supporting their efforts in developing education training. Furthermore, if we are to continue to attract faculty in the twilight of their career, we can make extra effort to perceive their attitudes regarding how the dental education environment has changed since their own experience as a student.

Dental Academicians

Faculty recruits into dental education have little knowledge of educational theory and teaching practices and have limited, if any, experience with policies, procedures, and general expectations of the academic environment (Bertolami, 2007). It is not enough for a faculty member to be an exceptional clinician. She or he must be a distinguished teacher as well. More specifically, they must be willing to base their activities on theoretical knowledge (Ramsden, 2003). It is now recognized that preparing health professions faculty for their teaching responsibility is a necessary function of academic institutions.

This responsibility of the institution is encumbered by the increasing difficulty of attracting and retaining faculty in the first place. As has been widely discussed, academic

dentistry is graying rapidly and continues to struggle to attract younger dental professionals into the educational arm of the profession. For the academic year 2014–2015, nearly all dental schools had some full-time vacancies. In addition, deans reported that faculty recruitment and retention were significant problems, and more than half of dental school deans indicated that they expected filling vacant positions to become more difficult in the future (Wanchek Cook, Slapar, & Valachovic, 2016).

This institutional challenge is amplified by additional complexities in attracting the right faculty. On one hand, dental educators are navigating through an era when numerous fundamental changes in curriculum format and teaching/learning methods have been proposed in response to the warnings that "our educational system is in trouble" and that the "profession has lost its vision and may be wavering in the achievement of its goals" (Roth, 2007, p. 984).

On the other hand, the ranks of academia are increasingly populated by older but relatively inexperienced teachers moving in from the practice environment and bringing with them memories of the "way we were taught" in the 1970s and perhaps not eager to find themselves in the middle of a major overhaul in teaching methodology as they start what amounts to a transitional period between their primary career and retirement (Hendricson et al., 2017).

Dental Faculty of the Future

Bertolami (2007, p. 1269) addresses these challenges directly by stating:

Can anything be learned from the current dental faculty crisis as an aid to moving forward without, at the same time, focusing obsessively on the past? There is little point to concentrating on the origin of faculty shortages of the past, regardless of whether one's

viewpoint is accusatory or exculpatory, because both perspectives are moot: the people who will be needed in the future are likely to be quite different from those of the past.

We will only find these "quite different" faculty if our recruitment methods are also "quite different." The faculty needed in the future are those who have the ability to embrace student-centered teaching. They are willing to do more with less, break from traditional formats of teaching, and work across specialties, departments, and with other institutions. Unfortunately, a successful clinical career, teaching experience, awards, or a prominent list of references do not automatically translate to success as an educator. When recruiting, we might ask, "Does this person have the attitude, or mentality, to be a student-centered educator?" Student-centered educators have a certain attitude regarding their role as an educator. They never lose sight of the priority of their goals for student-centered learning; they are teachable as they listen to and learn from their students; they constantly evaluate their own performance. They understand that teaching is about making it possible for students to learn; they succeed in learning and integrating educational theory and effective classroom knowledge (Ramsden, 2003).

Deep understanding of learning and teaching and their relationship to each other is an essential base for effective action as an educator. No longer is the student expected to be a passive absorber of information; instead, the teacher acts as a facilitator and does not need to be an expert in the particular content.

CONCLUSION

The traditional dental school environment does not allow us to pursue disruptive changes because there is no immediate reason to do so. In-house disruptive innovation within our curriculum requires a commitment of resources that seems too costly when we refuse to accept how our profession might look in the not-so-distant future. The commitment to find and develop

student-centered faculty puts dental education in a position to discover, develop, and implement

curricular advancements that confront the professional disruptors that are sure to come.

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APPENDIX

1. Lesson Plan Instructions (Provided to Faculty prior to appointment)

This appointment is in conjunction with the upcoming Faculty Development Workshop Series organized by Dr. Dana.

Anything discussed, or any instructional materials shared will be protected and reviewed to gather data, and will then be deleted. This is not an evaluation of any sort. We're not evaluating you as the instructor, we're measuring the school as a whole. Information will be anonymous. We are just collecting data to create a baseline to measure effectiveness the Faculty Development Workshop.

- Ideally we would sit in on your class for an hour and a half, but since we can't do that, this interview will serve a replacement to observe what happens in your classroom.
    - We're trying to substitute this for an observation instrument that takes measure what happens every 2 minutes of your class, so the more specific you are about what you do and what your students do, the better
    - We need your help to feel as if we were sitting in your class
- Please choose a specific day of instruction (typical of your usual instruction)
- Be prepared to give a minute-by-minute accounting of what the faculty member is doing and what the students are doing during the instruction period.
- Be prepared to give any lesson materials (electronically or hard copy).
- Be prepared to walk researcher through ppt. slides.

- So I understand we're talking about your class on (date) OR can you tell me what day we're talking about?

2. Lesson Plan Calibration Guide for Researchers

Overall narrative of the discussion

- Faculty who "buy-in"
  - Nervous and Defensive-It's ok, we want to...
    - show the dean how much progress we've made
    - See if this training works
- NON-buy-ins
  - That's totally fine that you're doing great! We would like to know what you're doing

Lesson plan interviews (Proxy for the COPUS)

"I'm here just to get a run-down of what you do in a classroom"

"Let's first set up an email to my address so we can attach any content that we might use"

- Objectives
- How do you start?
  - Quiz
    - How long do they take to finish?

- - Do they start talking?

  - Do you go over it?

  - How long?

- Lesson material

  o Power points

    - What are the students doing during the PowerPoint?

      - Do they ask questions?

      - How often?

      - What do you think makes them ask questions?

    - Do you do any "break-outs" during this? YES. They might be using the term "break-out" in a general sense, it might not be active.

    - What do you do in the break out?

    - What are the students doing?

    - What are YOU doing?

      - Do you go around to them? Do you sit and observe? Do you prepare other things?

    - "iClicker" or "Poll Everywhere"

  o Sim Clinic

    - If they start talking about it, let them continue. Some lecture is done there. Continue to ask COPUS questions for the sim clinic

      - Keep documenting

        o Time frames

        o Lecture material

- o Doing a Demo.

    - ▪ What are students doing while you're demo-ing

- o Given videos to students to view

- o What other learning material are you using?

    - ▪ They might say that it's on Blackboard, but make sure you get the name of it.

- ▪ Don't explicitly ask for it

- • Remind faculty this discussion is used in lieu of observing them in the classroom.

- • Assure faculty – this is anonymous, they are not being evaluated, anything you send will just be protected and reviewed for data purposes and then deleted. This certainly isn't to evaluate you as an instructor, it is just to collect data and to really show the dean where we've come (we need that baseline)

- • i.e. "So, I understand we are talking about March 22, 2017 where you were covering this particular topic."

- • "We are doing this in lieu of an observation instrument that collects data every 2 minutes. So, you can see the level of detail we are looking for with what is happening in the classroom. What do you do and what are your students doing in 2-minute intervals?"

- If they administered a clicker question or asked a question, make sure you ask them whether this is something the students would know already (are you just asking them to recall information) or is it something that they are guessing on or to get them engaged.

- While they are lecturing, ask if students are interrupting with questions or not.

- Ask about anything they are doing which might increase or decrease engagement

- Make sure you thank them for their time and make sure they send the email with the files (or bring a thumb drive for materials that are too big to send

CHAPTER 3

Why Do Faculty Resist Change?

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ABSTRACT

Much of what an educator needs to know to be successful is invisible to lay observers, leading to the assumption that teaching requires little formal study. This study is based on an 8-month faculty development workshop project in which faculty members committed themselves to learning about and implementing student-centered teaching in their existing courses. For the purpose of gathering information we used a qualitative narrative approach based on a structured interview with participants of the faculty development workshop. Faculty resisters did not see any need for changes in the way we teach and did not believe student-centered teaching to be more effective, while faculty accepters were excited for changes and saw the need for change and for student-centered teaching. Furthermore, those resisting change did not know the meaning of student-centered teaching (even though this was the focus of the workshop). It was also noted that faculty resisters were motivated by extrinsic factors (salary and recognition) but did not feel valued. On the other hand, faculty accepters were intrinsically motivated but did feel valued as a faculty member. The emerging themes from our analysis led us to the theoretical explanations offered by the status quo bias, which is a preference for leaving things as they are. Changes in pedagogy and curriculum are offered as a way of making gains in student learning. But some faculty only see the loss of what they have always done, which outweighs any potential gain.

INTRODUCTION

Initiatives to improve teaching are not unique to dental education. A systematic review examining teaching effectiveness in medical education concluded that faculty members in health professions education in general lack formal training in educational methodology and pedagogy, and therefore faculty development is needed (Steinert et al., 2006).

Furthermore, a major critique of higher education in general, going back at least to the 1970s, is aptly summarized by cognitive psychologists in 2003: "It would be difficult to design an educational model that is more at odds with current research on human cognition than the one that is used at most colleges and universities" (Halpern, & Hakel, 2003, p. 4). Yet many faculty members seem unaware of this research or resist giving it serious attention.

As Derek Bok, president *emeritus* of Harvard, has put it, "No faculty ever forced its leaders out for failing to act vigorously enough to improve the prevailing methods of education. On the contrary, faculties are more likely to resist any determined effort to examine their work and question familiar ways of teaching and learning" (2009, p. 334).

Much of what an educator needs to know to be successful is invisible to lay observers, leading to the assumption that teaching requires little formal study. Teaching expertise is often assumed to be part of content expertise; in other words, if a faculty member has acquired the knowledge of a certain discipline (e.g., dentistry), they are qualified to teach. As a result, faculty tend to teach in the way they themselves were taught, using instinct, trial and error, and personal experience (McAndrew, Motwaly, & Kamens, 2013). However, over time, teaching has come to be recognized as the separate skill that it is. While intertwined with knowledge of content, teaching expertise is separate from content expertise (Darling-Hammond, 2010).

While the lack of teaching expertise is an identified problem throughout health professions education, it is particularly acute in dental schools, where a survey of dental faculty workforce issues published in 2008 reported that over half of new faculty members coming into dental education were from private practice (Chmar, Weaver, & Valachovic, 2008). Additionally, 18–21% join dental education after graduating from an advanced education program, where again there is little to no training in teaching as a part of specialty education. It therefore falls to the schools to teach their faculty how to teach, and there has been a concerted effort to infuse teaching education into dental schools via faculty development (Gadbury-Amyot, Smith, Overman, & Bunce, 2015).

Complicating the lack of formal education training for dental educators is the vigorous and frequent reminders that effective pedagogy has evolved, and what they have done in the past is outdated and needs to improve. This article proposes an explanation for individual resistance (or acceptance of) nontraditional educational pedagogies. The focus of the article is how faculty perceive administrative calls for improved teaching and how this process influences individual resistance of new or changing pedagogies. Procedures for decreasing individual resistance to (and, hence, increasing acceptance and use of) active learning methods are suggested.

METHODS

This study is based on an 8-month faculty development workshop project in which faculty members committed themselves to learning about and implementing student-centered teaching in their existing courses. The workshops were scheduled between January 2017 and June 2017 and were endorsed by the Office of Academic Affairs, who requested that all full-time faculty, adjunct faculty, and hygienists attend all sessions of the series. While research from this workshop indicated that detailed and directed pedagogical training could cause a change in

instructor teaching practice from teacher-centered to more student-centered methods, we sought further understanding about those who did not change.

For the purpose of gathering information we used a qualitative narrative approach based on a structured interview with participants of the faculty development workshop. Twenty faculty members participated in all of the workshops. We chose from among the many faculty who made significant changes to be our faculty accepters group. Only four faculty members made no changes at all. Two of these four agreed to participate in our interview process as faculty resisters.

The interviews took place 4 months after the completion of the faculty development workshop series. The privacy of the informants was achieved by receiving their written permission to record the interviews and by strict use of pseudonyms in all written transcriptions. All faculty members were asked the same questions before researchers completed thematic analysis:

- How did you teach before the faculty development workshops?

- How has your teaching changed since the faculty development workshops?

- What is your motivation to be an educator?

- What are your concerns with student-centered teaching?

- What evidence would convince you that student-centered teaching is good?

- What evidence would convince you student-centered teaching is bad?

- What was your opinion going in to the faculty development workshops?

- What would you change about the faculty development workshops?

- What resources should be provided to dental educators?

- What incentive structure should be in place for dental educators to transition there classroom to be more student-centered?

- How would you help someone else who is resistant to student-centered teaching?

All interviews were recorded and transcribed according to guidelines established in the IRB. Using transcription notes, a thematic analysis was completed on each of the completed interviews.

The procedure for this analysis required researchers to create themes from the data rather than establish groupings according to an existing theory. The data were read and then reread to categorize teacher views. Similarities and differences across and within participants were examined.

In order to avoid subjectivity in the initial selection of categories and to assure trustworthiness, these themes were identified by each of the four researchers separately, who then compared notes and agreed upon a list of preliminary categories of responses. The final themes were determined at a second and third phase. The primary author trained the researchers in the method before they began thematic analysis.

RESULTS

Generally speaking, faculty resisters did not see any need for changes in the way we teach and did not believe student-centered teaching was more effective, while faculty accepters were excited for changes and saw the need for change and for student-centered teaching. Furthermore, those resisting change did not know the meaning of student-centered teaching (even though this was the focus of the workshop). It was also noted that faculty resisters were motivated by extrinsic factors (salary and recognition), but did not feel valued. On the other

hand, faculty acceptors were intrinsically motivated, but did feel valued as a faculty member.

See Table 3.1

Table 3.1

Thematic Differences Between Faculty Resisters and Faculty Accepters

Faculty resisters	Faculty accepters
Don't see a need for change	Excited, and see a need for change
Don't know what SCT is	Want to know what SCT is
Don't think SCT is better	Recognize SCT is better
Extrinsic Motivation	Intrinsic Motivation
Don't feel valued	Feel valued

Within each of the themes noted above were comments illustrating the frustration felt by some faculty that what they were doing was no longer relevant. Regardless of the clinic expertise they bring to their students, the vigorous and frequent reminders that effective pedagogy has evolved and what they have done in the past is outdated and needs to improve created communication barriers and affected buy-in for what they saw as unnecessary mandates from administration.

A Need for Change?

Faculty accepters were excited, grateful, and appreciative of the pedagogical training. These faculty members sensed that students were hungry for reform and that traditional models of education were not effective. Furthermore, they even suggested that there should be accountability for those faculty unwilling to change their teaching methods.

In contrast, faculty resisters saw no reason to change. Comments from these faculty members suggest a weariness and frustration with change efforts, indicating that they felt like the system did not need fixing. These faculty also mentioned their teaching experience and the awards they had received as evidence of their effectiveness. One faculty member indicated that change mandates stemming from dental educators with additional degrees were "dangerous." Example quotes from interviews are shown in Table 3.2.

Table 3.2

Example Quotes Regarding the Need for Change

Faculty resisters— Don't see a need for change	Faculty accepters— Excited, and see a need for change
"I rebel against [being asked to change]. I'll be quite honest with you. But as I say that, I don't think there isn't room for improvement. Um, but my opinion is that if, I hate to say this, if it's not broken, let's not fix it."	"I was excited. Like when the Dean said we are going to transform education, I was excited. Yeah! Let's do this!"
"One of the problems in dental education is that a lot of things are being changed just for the sake of change. They start changing things just for the sake of changing them, and they throw things away that are really good."	"I am grateful to this school, the dean, and this workshop! It's made a difference for me and I really appreciate it, even though it's been a lot of work."
"I'm going to say something that's going to throw you for a spin. I have had a lot of experience, and personally I think that dentists get higher degrees in education, and start applying those things in	"I was in private practice for 25 years before I came here. And, it's like, if you are not meeting the outcomes you are out of the game. You are out of business. You are done. The education model is not like that. It's like you can sleep and lumber

dental education, and I think it can get a little bit dangerous."

"My opinion is that if it's not broken, let's not fix it."

"I was offered a job and I made an immediate impact, which I expected because I've had ten years of teaching experience."

"that is what is so puzzling to me, is why, if we were doing so well (residency acceptance, board scores), do we have to shift gears totally in what we're doing?

"I was applauded at my previous institution."

"[At my previous institution] I got positive regard from fellow faculty and administrators all the time. Makes me wonder, 'why the heck did I leave there?'"

"[At a previous institution] I was given an award five years in a row by the students for excellence in teaching. Since coming here I have also received those awards. What that tells me is that my method works."

along under the radar for your whole career. I think there needs to be some consequence."

"It seems students are hungry for something different."

"There is an extreme need for reform."

"My motivation was, I had always felt, personally I had always felt like something is wrong with education. We're not getting the most out of it, or it's not as effective as it could be."

"There should be some accountability for not changing."

Understanding Student-Centered Teaching

After the faculty workshop, those incorporating a more student-centered approach were quick to admit their need to learn more about effective pedagogy. Those maintaining traditional methods seemed to not yet understand the principles of student-centered teaching, either admitting that that was the case or claiming to have already adopted the methods (which was contrary to data collected via classroom observation protocols). Example quotes from interviews are shown in Table 3.3.

Table 3.3

Example Quotes Regarding the Understanding of Student-Centered Teaching

Faculty resisters— Don't know what SCT is	Faculty accepters— Want to know what SCT is
"Student-centered vs. teacher-centered. That makes no sense to me."	"I have so much to learn. I want to be better."
"I'm already using all the methods being taught in this workshop."	"I want to be a good teacher, but I need help."
"I'm under the impression that people think [the way students learn] has changed, but I don't know if I buy that."	"When I first came here to teach, I would sit through other lectures and realize, this is painful!" When I started doing my own research into education I realized there was a much better way. I just didn't know how to start."
	"I have a lot to learn, but I do know that we learn by doing!" You don't ride a bike by talking about it. You get on it, you fall down, you get up and you do it again."
	"My only concern is that I have so much to learn! I need to get better at how I implement [active learning] and do it."

Confidence in Student-Centered Teaching

During the faculty development workshop series, evidence was presented to highlight the research behind student-centered teaching. Despite the presentations, not all were confident in the research. Faculty accepters referenced the positive experiences they had with students, and the positive comments made by students. They mentioned the data and were confident the new method was effective.

On the other hand, faculty resisters were not confident in the approach and worried that the new teaching styles would not effectively prepare students for their board exams. Example quotes from interviews are shown in Table 3.4.

Table 3.4

Example Quotes Regarding Confidence in Student-Centered Teaching

Faculty resisters— Not convinced SCT is better	Faculty accepters— Recognize SCT is better
"It seems we are being asked to throw away everything we're doing and let's be entertainers to these students."	"When I taught using the new techniques [taught in the workshop], the students loved it! They asked me, 'why didn't we do it this way sooner?'"
"things are trying to get so accelerated and so streamlined, so to speak, that we're leaving out some real fundamental things."	"The research is clear that lecture doesn't work."
"[Active learning] has some positive attributes. There are some that go a little further than I'm willing to go. I've always done it my own way."	"The way I was taught was PowerPoint and 'read the book.' And then you go to class and are just expected to regurgitate what you just read. I know I personally learn through discovery, but that is not how we teach."

"I'm just worried about the board results, and I'm worried about the students."

"We may be facing a problem with the board, with a failure rate. I have had a 100% pass rate with the board, but now I don't know what is going to happen. I'm predicting a higher failure rate on the boards."

"There is so much data out there! I mean, going back to the early 1900s that lecture is not an effective way to deliver material that is going to be retained long term."

"I am so excited to improve and change. The learning model here is focused on active learning. That is what drew me to this school."

"I knew [lecture] wasn't the best."

"After changing my class, students expressed appreciation. They knew that there was effort placed in the teaching method vs. just putting out a PowerPoint lecture and talking about it."

"With this class I had so much more feedback than before. Students were like, 'wow, this has been awesome.'"

"It was a lot of work to change my class, and sometimes I was like, 'ahhhhhhhhh!' But once you get the feedback from students, OK, it was worth it."

"[My supervisor] and the Dean have been very forthcoming in their praise for the changes I am making, and that is rewarding. But the reason I am changing is because I feel like it's just a better way that learning happens. That is why I got into education in the first place."

Motivation

The faculty who adopted student-centered methods made comments suggesting they were more intrinsically motivated. For example, they wanted to be better and mentioned doing what was best for the students. Those rejecting these changes were more motivated by extrinsic factors such as salary and recognition. Example quotes from interviews are shown in Table 3.5.

Table 3.5

Example Quotes Regarding Motivation for Change

Faculty resisters— Extrinsic motivation	Faculty accepters— Intrinsic motivation
"I think money would be a good incentive"	"I love working here at [this school]. I wanted to be better, I wanted to be an asset to the University, so I had to step out of my comfort zone."
"As an incentive, I think that monetary, and a rank advancement would be a good incentive."	"I was initially resistant to change because I was scared, but I realized how much I care about the students. That is what motivates me to improve."
	"If I were to discover that there is something that I am doing that could be improved, then I would do it. I don't know that getting an award from the Dean, something that I could put on my door or my wall or whatever, is going to motivate me."
	"So my main motivation would probably be. . . I just feel [the students] learn better."
	"My biggest motivator is internal drive for excellence, and then the second biggest is I need to provide for my family."

Feeling Valued

Whether or not the faculty felt valued at their institution was also a theme that emerged from the interviews. Those who changed their teaching practices felt valued while those who did not change their teaching did not. Furthermore, these faculty members mentioned a negative culture. Example quotes from interviews are shown in Table 3.6.

Table 3.6

Example Quotes Regarding Feeling Valued

Faculty resisters— Don't feel valued	Faculty accepters— Feel valued
"There has been no recognition here."	"I feel valued here at [this school], and that makes me want to improve."
Regarding feedback: "There has been nothing positive."	"Some people may be motivated by monetary compensation, but I think a bigger motivation for most people would just be recognition that you are valued. I have felt that here."
"It's been negative [at this institution] for sure." "Well, I'll tell you, one thing that would really help is if an administrator would come up to me and say, 'hey I heard you had a good […] course this year. Way to go! I'm glad you're here.'" "[Positive praise] has never happened here. Never! Not once."	

DISCUSSION

After the 8-month faculty development workshop, our research (this research is included in Chapter 2) indicated that detailed and directed pedagogical training could cause a change in instructor teaching practice from teacher-centered to more student-centered methods for many faculty participants. Specifically, for every category increase in experience (e.g., going from new educator to mid-level educator, or from mid-level to experienced educator), the normalized change toward student-centered-teaching *decreased* by 17.5%. Furthermore, for every one-point gain in student-centered mentality score (a measure of the faculty member's beginning attitude toward student-centered teaching), the normalized change toward student-centered teaching *increased* by 8.4%. Our research indicated that those with a more student-centered mentality were more likely to embrace student-centered practices in their courses. In addition, we found that faculty with more experience were less likely to change their teaching practices after pedagogical training (Dana, Soffe, & Jensen, 2019). In this project, we chose to utilize a narrative analysis to better understand the perspective of those rejecting change efforts.

The emerging themes from our analysis led us to the theoretical explanations offered by the status quo bias (Samuelson, & Zeckhauser, 1988), which is a preference for leaving things as they are. Changes in pedagogy and curriculum are offered as a way of making gains in student learning. But some faculty only see the loss of what they have always done, which outweighs any potential gain. The faculty members we interviewed who did not change were quick to mention their teaching experience and teaching awards as evidence of the effective status quo. That they were also motivated extrinsically by recognition allows us to gain insight into what they might lose if they were asked to change what they had always done. They might lose the recognition that had brought them to where there were now.

Why is the status quo bias so powerful? Samuelson and Zeckhauser (1988) theorized that it is often an effort to resolve cognitive dissonance, especially in terms of one's own worth as a decision maker: With his or her self-image as a serious and able decision maker comes a need to justify current and past decisions, whether or not they proved successful. Asking a faculty member to change how they teach may be perceived as an attack on what they have always done. Past choices are rationalized, and the rationalization process extends to current and future choices. Thus, an individual tends to discard or mentally suppress information that indicates a past decision was in error (since such information would conflict with his or her self-image as a good decision maker). The status quo bias is a pervasive bias against designed change, and the evidence indicates that it applies at least as powerfully to college professors as to any other segment of the population (Tagg, 2012).

Many of our faculty, however, accepted student-centered teaching, so it is important to ask, "why did only some of the faculty fall prey to the status quo bias?" As reported above, we found that faculty with more experience were less likely to change their teaching practices after pedagogical training and to resist student-centered teaching. This finding is consistent with the research reviewing the literature on the development of pedagogical knowledge for educators (Prosser & Trigwell, 2001). This data leads us to hypothesize that more experienced faculty have a stronger status quo bias when introduced to pedagogical change.

How can we create a career path for faculty who fear losing what they have in the present? Case studies detailing change efforts within dental education have indicated some success in implementing large scale changes throughout a curriculum (Nadershahi, Bender, Beck, & Alexander, 2013). A review of these case studies in light of the emergent themes from

our interviews would direct us to (a) discover solutions that involve faculty in discovering the perceived need for change, (b) understand the outcomes of student-centered pedagogies, and (c) properly motivate and value faculty in their ongoing efforts. The following recommendations are provided in view of our findings:

1. Frequently engage faculty in the process of changes. Devote enough time to present and discuss the reasons and benefits of reform.

2. Define and find consensus for a clear vision of reform. Identify appropriate outcome measures and set benchmarks to gauge success. Appoint an individual or office to gather data and report back to faculty.

3. Recognize faculty for outstanding contributions to student-centered teaching, and value these contributions equally with research and service when evaluating academic promotion.

4. Secure sufficient resources to support the reform effort, including academic promotion incentives and faculty development costs.

CONCLUSION

A narrative analysis allows us to focus on an individual perspective and is relevant when that story might be validated by a greater audience. With the ongoing discussion to change dental education and the subsequent findings of faculty resistance to these changes, this approach was seen as an appropriate investigation into pertinent barriers to change for faculty resisters. Understanding the restrictive pull of the status quo bias can give insight to overcome it as an obstacle for change.

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CHAPTER 4

What Are We Simulating in the Pre-Clinic?

Authentic Learning for Improved Clinic Outcomes

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ABSTRACT

While dental simulation laboratories are a vast technological improvement over benchtop practice, it is debatable whether this facilitates a smoother transition to clinic. Educational theories that have existed for decades are being recognized and referenced to better integrate the role of authentic context into our simulated learning environments.

In this paper, authenticity in simulated practice was hypothesized as a causal factor in learning dental procedures and developing technical hand skills. Three components of clinical performance were proposed that could be affected by non-authentic simulated practices: (a) the presence of an assistant, (b) the abbreviated amount of time given to complete a procedure in the clinic compared to the simulation clinic, and (c) the differences between plastic teeth and real teeth. Participants in the study were 84 first-year (D1) dental students enrolled in the 2017 Diagnosis, Treatment Planning, and Restoration of Dental Disease course. Students were divided into 2 groups of 42 students each. The traditional group experienced traditional simulation clinic while the authentic group experienced a more authentic simulation clinic.

Results showed that practicing with less time did not hinder the student's ability to perform, the use of more life-like teeth did not affect students' ability to develop hand skills (on the contrary, there was a perceived value for students in preparing them for clinic), and student performance increased when they worked with an assistant in the simulated environment.

Student performance can be affected as dental educators reconsider the educational content and the teaching methodology within the preclinical simulation clinics.

Keywords: dental education, authentic learning, high fidelity, simulation, preclinical education, psychomotor skills, constructivism

INTRODUCTION

Authenticity Simulation

Dental students in the 1990s were the first students to have access to shiny new sim labs that replaced benchtop practice done in the preclinical curriculum. There was certainly a buzz during this time regarding these new technologies that were meant to mimic clinic reality. The few studies done after simulation labs became the standard for all dental schools confirmed that students loved the change (Clancy, Lindquist, Palik, & Johnson, 2002).

This simple anecdote provides what we think is a characteristic illustration of both the unquestioned value of authenticity in education and the often-unreflective ways in which we speak of it. We see the purported real worldliness of a learning environment, technique, or task as so visually impressive (seemingly real) that we frequently call attention to this feature alone to legitimize our use of it.

Student perceptions aside, the literature regarding the impact of these simulation labs on student learning or the acquisition of technical skills is sparse. The few studies that were done indicated either that student performance on practical examinations was not altered (Chan, Frazier, & Caughman, 2000; Green & Klausner, 1984; Suvinen, Messer, & Franco, 1998), or that the data were inconclusive (Buchanan, 2001). A report that compared an older, traditional benchtop laboratory to a new simulation lab over a 3-year period indicated a reduction in the number of procedures that could be completed by students. In addition, the percentage of student grades in the A range decreased significantly (22.7% to 4.5%; Chan, Frazier, & Caughman, 2000).

Regarding authenticity, the simulator technology improved the structure of the preclinical environment, but it had little impact on the way schools taught preclinical procedures. In other words, the preclinical educational content has remained the same (Gaba, 2007).

The Missing *Content* in our Simulated *Structure*

Renewed emphasis in dental education has emphasized reasoning skills and adaptability to provide meaningful care in the future. Dental educators are being driven to acknowledge the importance of everyday contextualization within the educational content. Educational theories that have existed for decades are being recognized and referenced to better integrate the role of context in our learning environments (Brown, Collins, & Duguid, 1989; Duschl & Osborne, 2002). These advancements over the past century have exposed the potential of a theory that has existed for decades and is known as *constructivism*—the interdisciplinary view that we construct knowledge based on our cultural assumptions and prior experiences rather than through the efficient and rational calculation of the information at hand (Petraglia, 1998). With this view, knowing cannot be separated from the activities in which one engages, and learning is intimately connected to its contexts and purposes (Resnick, 1987). It is reasonable then, for Dunn (1994) to conclude that "instruction should take place in rich contexts in which this knowledge would subsequently be used. . . . In a word, they need to be authentic" (p. 84).

Given the theoretical rationale that authentic practice leads to better authentic performance (Woolley &Jarvis, 2007), we aimed in this study to determine which components of non-authentic simulation practice affect subsequent authentic performance. We attempted to capitalize on the improved structure of our technologically impressive simulation clinics and implement a richer context. We predicted that creating a better context for learning would

enhance students' acquisition of the technical skills we sought to impart in the simulated environment (Bush, 1991).

We proposed three components of clinical performance that could be affected by non-authentic simulated practices: (a) the presence of an assistant, (b) the abbreviated amount of time given to complete a procedure in the clinic compared to the simulation clinic, and (c) the differences between plastic teeth and real teeth. We wanted to determine which of these three factors were likely to impede authentic performance when students practiced non-authentically. In other words, which of these components were necessary to be included in simulation practice because their omission from practice had a negative impact on actual authentic performance?

METHODS

Ethics Statement

The Roseman University Institutional Review Board determined this study met the criteria for exemption according to regulations defined by the U.S. Department of Health and Human Services and FDA 45 CFR 46.101(b)(2) (PN#16-SJ-DM-1102). The study was conducted from January 2017 to June 2017.

Data Collection

Participants in the study were 84 first-year (D1) dental students enrolled in the Diagnosis, Treatment Planning, and Restoration of Dental Disease course. Students were divided into two cohorts, each with 42 students. To avoid crossover and potential inaccuracies between treatment groups, the two groups were physically divided; i.e., when one group was in the classroom, the other group was in the sim clinic, and vice versa. Classroom instruction was the same for both groups. The traditional group experienced traditional simulation clinic while the authentic group experienced a more authentic simulation clinic. These treatments are described below:

Traditional Group

This group was designed to mimic traditional simulation at a typical dental school. Students worked in a recently built simulation clinic with the most recent upgrades in simulators and typodonts. However, students worked alone, were given all 4 hours of a pre-clinic session to complete their project, and used traditional model teeth for their projects. Students were allowed up to three teeth per project. If a student made an error, they were allowed another tooth and could start over.

Authentic Group

To expose students to authentic pressures of clinic performance, students in this group were paired and assisted each other (*ASSIST), were only given 2 hours (half time) to complete projects (*TIME), and used high-fidelity model teeth for their projects that contained pulp chambers and simulated caries (*HF_TEETH). These students were only allowed one tooth per project. If they made an error, they simulated a clinic environment to correct their mistake (meaning, they dealt with the consequences accordingly).

Throughout the course there were four operative individual performance assessments (IPAs) to assess clinic readiness. Students were tasked to do a preclinical practical exam on the same procedure as they had practiced, without any aid from faculty members. To determine which components of authenticity were affected by the type of simulation practice in which the student participated, various levels of authenticity were incorporated into the traditional group's IPAs (Table 4.1). Please note that various experimental constraints necessitated a random assignment of members of the treatment groups to IPAs—we will describe the IPAs in the order that makes most sense to explain our experimental design.

Table 4.1

Treatment Conditions for the Traditional Group for Each IPA

Daily work (practice)	IPA_3	IPA_2	IPA_1	IPA_4
4 hrs. time	4 hrs. time	2 hrs. time (*TIME)	4 hrs. time	4 hrs. time
Normal teeth	Normal teeth	Normal teeth	High fidelity (*HF_TEETH)	Normal teeth
Work alone	Work alone	Work alone	Work alone	2° provider (*ASSIST)

IPA_3

To determine a baseline performance on IPAs, IPA_3 was identical to each treatment group's practice. The traditional treatment group was tested using normal teeth, extended time, and no assistant; the authentic treatment group was tested using high-fidelity teeth, shortened time, and an assistant. The authentic treatment group was given these same test conditions in all four IPAs.

IPA_2

To determine whether the time given for completion of procedures influenced students' ability to perform authentically, the traditional treatment group was given shortened time (*TIME) on IPA_2. All other variables remained the same as practice.

IPA_1

To determine whether the fidelity of teeth used influenced students' ability to perform authentically, high-fidelity teeth (*HF_TEETH) were added to IPA_1 of the traditional treatment. All other variables remained the same as practice.

IPA_4

To determine the effect of an assistant on students' ability to perform authentically, the traditional treatment was asked to use a secondary provider (*ASSIST) on IPA_4. We paired students from the authentic group (who had gained experience as a secondary provider) with those in the traditional group. All other variables remained the same as practice.

IPA Grading Procedure

The four operative IPAs for this course were the following:

1. IPA_3, Class IV composite resin preparation and restoration (#8 MLIF).

2. IPA_2, Class II composite resin preparation, and restoration (#14 MO).

3. IPA_1, Class III composite resin preparation and restoration (#8 ML).

4. IPA_4, Complex Class II composite resin preparation and restoration (#30 MODB).

There were six categories of the IPA rubric, each graded on a 4-point scale from 0–3. This allowed for a total of 18 possible points from each faculty grader (see Table 4.2). Furthermore, three faculty members graded each of the student projects independently, and then faculty scores were added together, making a total of 54 points possible for each IPA. All points were converted to percentages.

Table 4.2

IPA Rubric

	PATIENT CENTERED CARE	DISEASE ELIMINATION	PREPARATION REFINEMENT	RESTORATION REFINEMENT	COMFORT, HEALTH, & FUNCTION	"DO NO HARM"
(0) CRITICAL ERROR	1. Disregard for the patient- stretching patient lips over screws 2. No rubber dam or it doesn't properly isolate the working area	1. Healthy tooth structure removed. Prep extends far beyond diseased area 2. Pulpal exposure 3. Residual decay present	1. Innapropriate margin conditioning that would negatively impact longevity and integrity of the restoration.	1. Residual debris or biofilm present 2. Excessive expression of restorative materal 3. No wedge or is ill fitting 4. Matrix is not restoring contact area 5. Marginal voids or defects 6. Composite puddled in bonding agent &/or flowable 7. Insufficient composite placed to fill entire restorative area	1. Voids, defects, scratches, lack of shine 2. Open contacts or embrasure spaces 3. High occlusion	1. Damage to adjacent hard or soft tissues that requires surgical intervention
(1) NEEDS IMPROVEMENT	1. Haphazard, disorganized instrument tray 2. No regard for time	1. Excessive tooth reduction beyond caries elimination without violating the pulp	1. Preparation needs refinement to optimize the retention and resistance form.	1. Form, function, and/or appearance would not be acceptable to a patient	1. Does not have "wet glass" appearance, lack of shine	1. Damage to adjacent hard tissues that requires additional finishing and polishing.
(2) CLINICALLY ACCEPTABLE	1. Necessary instruments and materials out and organized 2. Manikin treated as a live patient 3. Properly placed rubber dam 4. On time, ready to go at appointment time	1. Complete minimally invasive removal of decay 2. Outline form represents diseased area of tooth	1.Adequate preparation for optimal adaptation of restorative material	1. Tooth restoration interface free of debris and/or biofilm 2. Matrix and wedge provide complete seal of buccal, lingual & gingival borders 3. Matrix provides proper contact & contour 4. No voids or defects present. 2. Restoration is not underfilled or overfilled	1. Restoration exhibits "wet glass" appearance. No flash, scratches or defects are present 2. Ideal contacts and embrasures 3. Balanced occlusion	1. No damage to adjacent hard or soft tissues
(3) EXCELLENT	1. Faculty could not find anything needing correction or warranting feedback. Far beyond expected sim clinic expertise.	1. Faculty could not find anything needing correction or warranting feedback. Far beyond expected sim clinic expertise.	1. Faculty could not find anything needing correction or warranting feedback. Far beyond expected sim clinic expertise.	1. Faculty could not find anything needing correction or warranting feedback. Far beyond expected sim clinic expertise.	1. Faculty could not find anything needing correction or warranting feedback. Far beyond expected sim clinic expertise.	1. Faculty could not find anything needing correction or warranting feedback. Far beyond expected sim clinic expertise.

Note. There were six categories of the IPA rubric: (a) patient-centered care, (b) disease elimination, (c) TRI refinement, (d) TRI preservation, (e) comfort, health, & function, and (f) "do no harm." Each of these categories were graded on a 4-point scale from 0 to 3: (0) critical error, (1) needs improvement, (2) clinically acceptable, and (3) excellent.

All student identifiers were removed from the data prior to grading. All faculty member graders were trained by the course directors prior to the course and prior to each IPA to ensure standardization. All IPAs were graded independently and graders were not made aware of which treatment condition each subject was in.

Statistical Analysis

To test which components of non-authentic simulation affect authentic performance, we ran independent ANOVAs on each IPA and applied a Bonferroni correction to account for alpha inflation by multiple tests. We used the treatment condition (traditional versus authentic) as their between-subjects factor and the student's score on the IPA (i.e., development of hand skills) as the dependent measure. We analyzed GPAs and DAT scores to be used as potential covariates to account for group non-equivalence and found the groups to be equivalent (GPAs and DAT scores for each treatment group are included in Table 4.3.).

In addition, we gathered attitudinal data to compare between sections to see if any differences were seen. Specifically, surveys asked questions regarding the students' perception of the relationship between simulated experiences in the pre-clinic and live patient clinic pressures.

Table 4.3

Analysis of GPA and DAT Scores Between Treatment Groups

	Traditional group	Authentic group	T, *p*-value
Total GPA	3.38	3.32	0.85, 0.40
DAT perceptual ability	21.02	20.88	0.31, 0.78
DAT academic average	19.81	19.48	1.01, 0.32
DAT total science	19.74	19.45	0.80, 0.43
DAT reading comprehension	21.19	20.67	1.00, 0.32

Note. Analysis of GPA and DAT scores found no significant difference between the groups ($p < .05$).

Affective Data

We administered a 20-item attitudinal survey targeted toward the variables being tested (i.e., teeth, time, assistant). The survey was administered to both groups 3 months after the conclusion of the course, after students had matriculated into the clinic environment. Survey questions addressed how well the daily practice prepared them for what they would see in the clinic. The complete survey is available upon request. Survey items were graded on a 5-point Likert scale, with occasional free-response follow-ups. Data was analyzed using Mann-Whitney U tests to compare distributions to look for trends between groups in reference to any particular manipulated variable.

RESULTS

Our research intended to explore which elements of the simulated environment do not effectively transfer to the clinic. Controlling for undergraduate GPA and DAT scores, we found that when the assessment was structured according to the way they practiced (IPA_3) students in the authentic group performed better on hand skill practical examinations than those in the traditional group. The other IPAs begin to explain this observation (Figure 4.1).
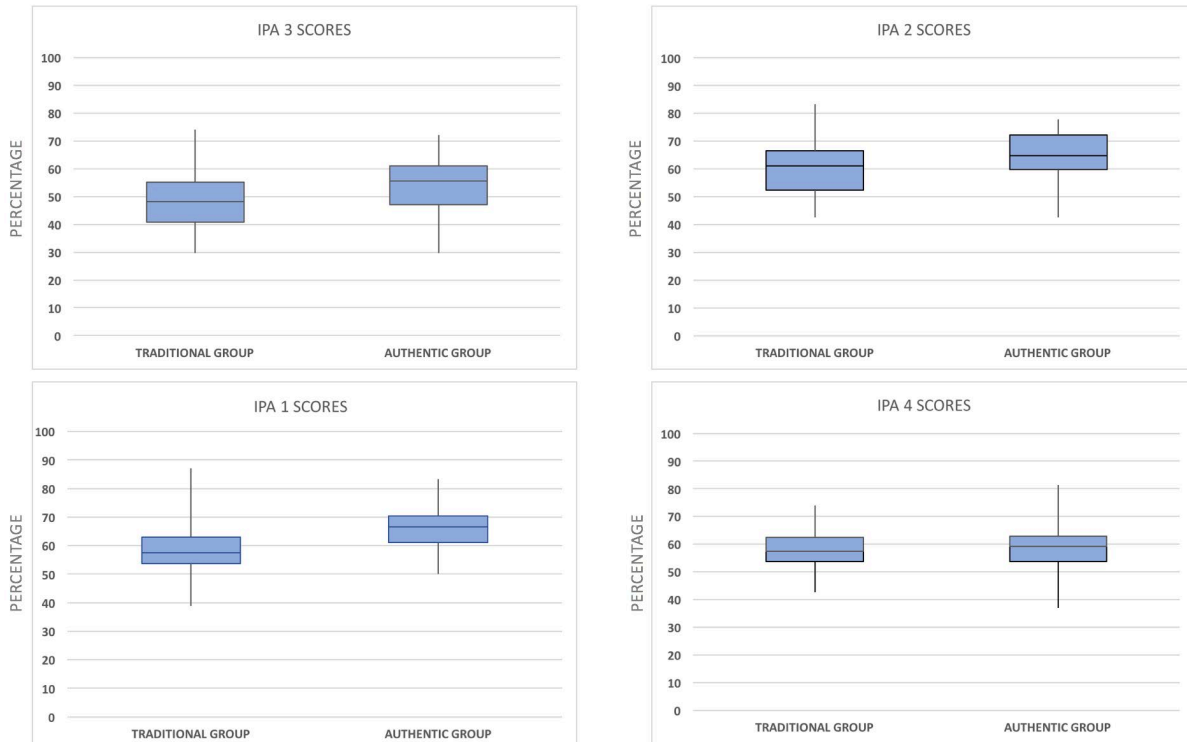

Figure 4.1. Assessment Results for Authentic and Traditional Groups. Students in the authentic group performed better on hand skill practical examinations even when the assessment was structured according to the way they practiced (IPA_3), and in the subsequent IPA_2 and IPA_1. It was not until IPA_4 that students in the traditional group were able to catch up.

IPA_2 showed that *TIME was not a factor for students. For this assessment, the traditional group was asked to perform in half the time they were given for practice, but did no worse than they had done previously, still performing 10.0% lower than the authentic group. In other words, the performance gap between traditional and authentic remained the same.

Furthermore, analysis of IPA_1 showed that being asked to perform on high-fidelity teeth (containing caries and pulp chambers) was not impacted by non-authentic practice. The traditional group did no worse in this assessment when asked to perform on high-fidelity ivorine teeth after practicing on standard ivorine teeth. Again, the performance gap remained constant (We have chosen the word fidelity to describe a more authentic plastic ivorine tooth used in the preclinical simulation labs. These teeth contain pulp chambers and have been altered to contain simulated decay).

However, IPA_4 was the assessment where there was a significant change in the performance gap between groups and indicated that performance improves when students are given an assistant for their assessments (Table 4.4 and Figure 4.2).

Table 4.4

Analysis of IPA Performance Differences Across Treatment Groups

	Traditional group	Authentic group	Performance gap	*p* value
	M, SD	*M, SD*	*M, SD*	*F, p*
1 (IPA_3)	48.72, 10.16	54.10, 10.62	5.38	5.63, 0.020
2 (IPA_2)	60.36, 9.24	65.21, 8.22	4.85	6.47, 0.013
3 (IPA_1)	57.41, 10.91	66.27, 6.96	8.86	19.71, 0.000
4 (IPA_4)	57.89, 7.14	58.16, 7.41	0.26	0.03, 0.868

Note. Analysis of GPA and DAT scores found no significant difference between the groups ($p < 0.05$).
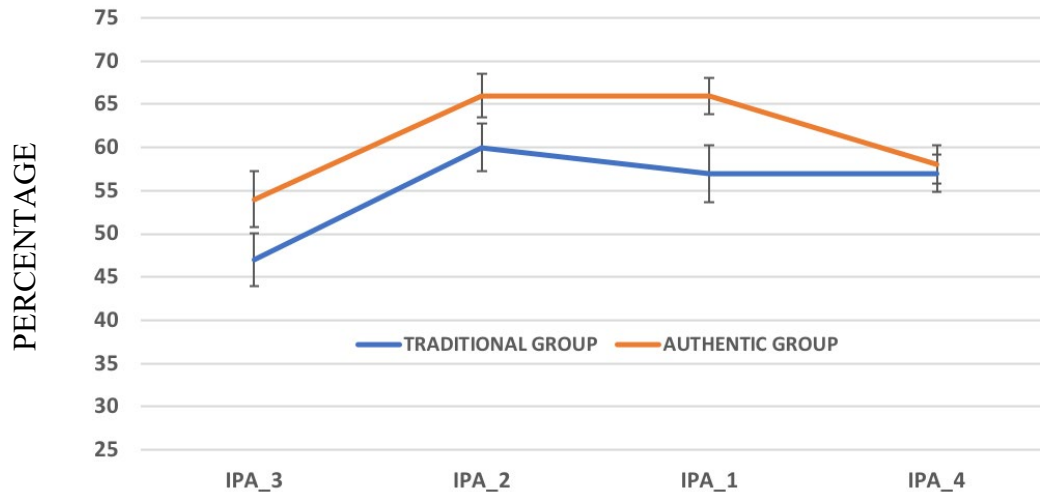
Figure 4.2. Traditional Group removed the performance gap in IAP 4. The traditional group removed the performance gap during IPA_4—As seen in 1 (IPA_3), the authentic group did better than the traditional group even when both groups were assessed in the same way they practiced. The performance gap from 1(IPA_3) is interesting and certainly notable, but does not answer why the authentic group performed so much better. The performance gap between 1 and 2 and between 1 and 3 did not change significantly. However, for 4(IPA_4) there was a significant change in the gap. Both groups performed the same.

Affective Data

Of the 20 questions asked, five items showed significant differences between the treatment groups (See Table 4.5). Attitudinal data scores for the authentic group were significantly higher than for the traditional group when asked if working as an assistant and with an assistant in the simulation clinic was valuable, helped prepare them for clinic, and helped produce high-quality work. Attitudinal data scores were also higher when asked if the time they were given for their daily projects helped them become more efficient and more prepared for the clinic and when asked about their preference using the higher fidelity teeth.

Table 4.5

Attitudinal Data Scores for the Traditional and Authentic Groups

					Mean rank			
Item #	Survey question	Traditional group	Authentic group	*p*	Traditional	Authentic	U	Z
3	Working *as* a secondary provider was valuable to my learning process and helped prepare me for clinic.	2.579	4.048	0.000	27.18	46.50	336	-3.94
4	Working *with* a secondary provider was valuable to my learning process and helped prepare me for clinic.	2.868	3.952	0.002	30.10	45.30	429	-3.11
5	The time I was given for IPEs (daily projects) helped me become more efficient and prepared me properly for real	3.421	4.119	0.000	31.86	48.32	470	-3.51

15	life clinical experiences. Working *as* a secondary provider helps me produce high-quality operative restorations when I work as a primary provider	3.237	3.833	0.018	33.76	45.5	546	-2.37
16	When working in the Sim Clinic, I would prefer to work on teeth containing simulated caries and simulated pulp chambers.	4.474	4.714	0.033	35.58	44.1	611	-2.14

Attitudinal data scores for the authentic group were statistically significantly higher (mean rank = 46.50) than the traditional group (mean rank = 27.18), $U = 336$, $z = -3.94$, $p = 0.000$, when asked if working as an assistant in the simulation clinic was valuable and helped prepare them for clinic; and when asked if working with an assistant (mean rank = 45.30 vs.

30.10), $U = 429$, $z = -3.11$, $p = 0.002$. Furthermore, the authentic group responses were also significantly higher when asked if working as an assistant helped them produce high-quality work when they were the primary provider (mean rank = 45.50 vs. 33.76) $U = 546$, $z = -2.37$, $p = 0.018$. The *TIME variable was also relevant in the attitudinal data. Attitudinal data scores for the authentic group were statistically significantly higher (mean rank = 48.32) than the traditional group (mean rank = 31.86), $U = 470$, $z = -3.51$, $p = 0.000$, when asked if the time they were given for their daily projects helped them become more efficient and more prepared for the clinic. And finally, when asked about their preference for using the higher fidelity teeth, attitudinal data scores for the authentic group were also significantly higher (mean rank = 44.10) than the traditional group (mean rank = 35.58), $U = 611$, $z = -2.14$, $p = 0.033$.

DISCUSSION

Is it possible that our references to the technology of dental simulation labs are rhetorical attempts to "make learning real?" Today's dental educators are facing a weighty challenge with our current mandate for case-based and integrated content to give context to our instruction (MacNeil & Neumann, 2007; Pyle et al., 2006). This pedagogical contextualization has grown more significant and intellectually demanding even as it remains imprecise and untheorized. Previous models of education have emphasized accuracy and demonstrability: the student learned the "right" information and proved this to his or her evaluator in an explicit manner. The ability to apply the correct information to the external world has been, for the most part, unquestioned.

The emphasis on authentic learning environments has been examined in other fields within the health professions. For example, researchers looked at developing authentic clinical simulations to assist practitioners to effectively communicate with children undergoing medical

care. Their work distinguished between authentic simulations, which consider the complexity and context of the application, and non-authentic simulations, which focus only on the skill to be learned (King et al., 2016). In physical therapy education, researchers looked at the authentic practice environment to provide students with opportunities to practice psychomotor skills and clinical decision-making skills in a way that is safe and low risk to patients. Their findings indicated that simulating authentic environments served a valuable role in entry-level physical therapy education (Pritchard, Blackstock, Nestel, & Keating, 2016). Furthermore, a dental hygiene program studied authentic simulation experiences meant to prepare dental students for managing medical emergencies. The results indicated that authentic learning was effective in helping the students identify the medical emergency in a timely manner (Bilich, Jackson, Bray, & Willson, 2015).

Our findings that the authentic group outperformed the traditional group allow us to reconsider the educational content and the teaching methodology of a traditional dental simulation lab. These findings within the authentic group mirror the educational research cited in other fields. Furthermore, we wanted to know which variable of the authentic practice was responsible for the performance gap between the traditional and authentic treatments.

Efficient Delivery of Care

When the traditional group was asked to perform in less time than they were given for practice, the change in the performance gap between groups was not significant. From this we conclude that practicing with more time than they are given for an assessment does not appear to hinder the ability to perform. Notwithstanding, we can also conclude that students do not need all the time they are given for practice. Students can perform equally well when they are given less time.

It is generally recognized that our clinics are inefficient providers of care and dissimilar in most respects to private practice. There is an understanding that treatment in the dental school clinics will meet the standard of care, but what patients save financially will be paid for in the extra time obtaining care. The inefficiency in our clinics remains a concern for our patients as well as our students (Henzi, Davis, Jasinevicius, & Hendricson, 2006).

Setting time expectations from the beginning of the learning environment allows us to facilitate transition to the clinic. We want our students to see more patients in a day to increase productivity and to increase patient satisfaction and efficiency. This expectation of efficiency can begin the very day they begin an authentic pre-clinical simulated clinic experience. This is accomplished in our curricular content and in how we assess our students as they provide patient care in the simulation clinics. Our research shows that novice students in their first months of the D1 year can complete restorative projects in the same amount of time provided a fourth-year student in the clinic. Furthermore, they feel this preclinical time constraint is valuable in preparing them for authentic clinic experiences. This expectation will remain with our students as they transition to our clinics. Instead of an entire morning session to see one patient, we recommend setting time constraints like what is done in scheduling patients in private practice.

High-Fidelity Teeth

IPA_1 indicated that students could perform on more authentic high-fidelity teeth (*TEETH), even if they had not practiced with them. The authentic group practiced using ivorine teeth with simulated caries and pulp chambers. In addition, they were not allowed to start over in practice if they made a mistake. Instead, they were required to address the problem as if they were in clinic. In contrast, the traditional group did not use these higher-fidelity teeth for practice and could start over when they made a mistake. But, when these authentic requirements were

placed upon the traditional group during their assessment, they performed equally well (i.e., the performance gap remained the same). This requires us to reconsider our hypothesis that high-fidelity teeth would induce clinic-like pressures.

Nevertheless, student surveys were very clear in expressing preference for the high-fidelity teeth (although, those who had direct experience with the high-fidelity teeth actually showed greater preference). Students reported positive experiences: "The large irregular lesions and pulp chambers made me use my tools and thinking skills in ways I hadn't before." "Having simulated caries/pulp chamber makes the experience more life-like and forces me to do the work well, form good habits and understand tooth anatomy." "Simulated caries + pulp rock! It helped me make a prep that made sense." "The teeth w/caries and pulp chambers was helpful for students to experience 'real' teeth." "It helps us learn to make preps that match what the caries are not necessarily just certain dimensions."

Working Together

We have found that the most significant advantage to performance in an authentic situation is the ability to effectively use a secondary provider. As evidenced from IPA_4, by providing a secondary provider during assessment, we were able to close the performance gap between those students who practiced traditionally and those who practiced authentically. Certainly, most dentists would acknowledge the value of the use of a dental assistant (four-handed dentistry) in their respective offices. Despite the necessary interest in the issue of efficiency and the renewed recommendations by the Occupational Safety and Health Administration (OSHA) regarding ergonomics, few dental schools teach the concepts of four-handed dentistry as part of the curriculum. The result is that many dental graduates learn four-handed dentistry on the job (Finkbeiner, 2000).

Placing value on the role of an assistant meant implementing their use from year one in the pre-clinic simulation clinics, as well as altering the culture of "just the assistant." Students are no longer assigned as an "assistant," but as a primary or secondary provider. The role of the secondary provider is to assist the primary provider, but includes much more. The secondary provider must develop a thorough understanding of the procedure, recognize the patient's needs, anticipate the operator's need, and recognize any change in the procedure. When this set of criteria is implemented from the beginning of the dental curriculum, the students' transition to their role as a secondary provider in the clinics is less of an obstacle, and they themselves begin to see the value. Not only did our students feel that working as a secondary provider was valuable and helped prepare them for clinic, but they even recognized that working as a secondary provider helped them produce high-quality operative restorations when they were the primary care giver.

Limitations

Throughout the course, the authentic group consistently performed better on assessments than the traditional group. The reasons for this performance gap were not completely understood until IPA_4. While we have shown that using an assistant is beneficial for students during a high-stakes assessment, it is important to note that we have not yet shown it is beneficial during practice. We are currently involved in a follow-up study to look at this possibility.

The assistants for IPA_4 were the students from the authentic group who had been performing better on previous assessments. Because the traditional group was assisted by the better performing authentic group, it is possible that the increased performance was simply a result of increased scaffolding provided by more capable peers (Wiggins & McTighe, 2005).Would the traditional group still have performed this well if they had been assisted by

each other (equally skilled partner)? Or, can we credit the known value of peer-to-peer mentoring and team-based learning for this significant finding? Further research into this relationship is needed.

We also note a potential threat to internal validity in that IRB required that the students be informed of their inclusion in a study. The traditional group often felt disadvantaged, as evidenced by frequent comments made to the instructors, and may have performed worse accordingly. Furthermore, the authentic group may have put forth greater effort just to confirm the researchers' hypotheses. The only potential way to avoid this issue would be to run the two treatments over two alternating years; however, separating treatment conditions in such a way introduces many other potentially uncontrolled variables. Thus, concurrent running of the treatments was the favorable option, but it should be noted that confirmation bias by participants may be present.

RECOMMENDATIONS

We are encouraged by the initial data, as well as the anecdotal viewpoint of both students and faculty. Based on our results, we recommend reconsidering the amount of time dedicated to timely repetition of specific technical skills acquired in the preclinical years. An understanding that extended time for practice is not necessary for authentic performance would suggest that students be given more authentic time frames to build an understanding of the value of efficiency early in their training that can transfer to their work in the clinic.

Although utilizing higher fidelity teeth in the sim lab does not directly influence the students' acquisition of technical skill, there is value in the perception and context provided. Based on student survey responses, students perceived additional benefit by using higher fidelity teeth.

Finally, creating the culture where four-handed dentistry is both valued and recognized for its efficiency provides more than its expected impact on clinical production, but it is also a useful tool that leads to increased performance as students learn early to work together.

It is our intent to demonstrate the emergence of the concept of authenticity from irrelevance and rhetoric to more purposeful, data-driven changes to the preclinical environment. As an aim of higher education, authenticity is not simply an optional accessory, but an educational method that is beginning to carry theoretical weight. With the increased adoption of constructivist theories, authenticity has emerged not as a recommended practice, but as a cornerstone of scientifically informed pedagogy.

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