

Children's Mercy Kansas City

SHARE @ Children's Mercy

Manuscripts, Articles, Book Chapters and Other Papers

11-1-2016

Flipping the Classroom: Assessment of Strategies to Promote Student-Centered, Self-Directed Learning in a Dental School Course in Pediatric Dentistry.

Brenda S Bohaty
Children's Mercy Hospital

Gloria J. Redford

Cynthia C. Gadbury-Amyot

Follow this and additional works at: <https://scholarlyexchange.childrensmercy.org/papers>



Part of the [Dentistry Commons](#), [Educational Methods Commons](#), and the [Pediatrics Commons](#)

Recommended Citation

Bohaty BS, Redford GJ, Gadbury-Amyot CC. Flipping the Classroom: Assessment of Strategies to Promote Student-Centered, Self-Directed Learning in a Dental School Course in Pediatric Dentistry. *J Dent Educ.* 2016;80(11):1319-1327.

This Article is brought to you for free and open access by SHARE @ Children's Mercy. It has been accepted for inclusion in Manuscripts, Articles, Book Chapters and Other Papers by an authorized administrator of SHARE @ Children's Mercy. For more information, please contact hlsteel@cmh.edu.

Flipping the Classroom: Assessment of Strategies to Promote Student-Centered, Self-Directed Learning in a Dental School Course in Pediatric Dentistry

Brenda S. Bohaty, DDS, PhD; Gloria J. Redford, DDS; Cynthia C. Gadbury-Amyot, MS, EdD

Abstract: The aim of this study was to explore student and course director experiences with the redesign of a traditional lecture-based course into a flipped classroom for teaching didactic content in pediatric dentistry to second-year dental students. The study assessed student satisfaction, extent of student engagement, overall course grades, and course director satisfaction. The students enrolled in a flipped classroom pediatric dentistry course (spring semester 2014; SP14) were asked to complete pre- and post-course questionnaires to assess their perceptions of active learning, knowledge acquisition, and course satisfaction. The process was repeated with the class enrolled in the same course the following year (SP15). Responses for SP14 and SP15 resulted in an overall response rate of 95% on the pre questionnaire and 84% on the post questionnaire. The results showed that the greatest perceived advantage of the flipped classroom design was the availability and access to online content and course materials. Students reported enhanced learning due to heightened engagement in discussion. The results also showed that students' overall course grades improved and that the course director was satisfied with the experience, particularly after year two. Many calls have been made for educational strategies that encourage critical thinking instead of passive learning environments. This study provides one example of a course redesign and demonstrates the need for both faculty and student development to ensure success when a flipped classroom methodology is introduced.

Dr. Bohaty is Nelson Professor and Chair, Department of Pediatric Dentistry, School of Dentistry, University of Missouri-Kansas City and Pediatric Dentistry Residency Program Director, Children's Mercy Hospital; Dr. Redford is Clinical Assistant Professor, Department of Pediatric Dentistry, School of Dentistry, University of Missouri-Kansas City; and Dr. Gadbury-Amyot is Professor and Associate Dean of Instructional Technology and Faculty Development, School of Dentistry, University of Missouri-Kansas City. Direct correspondence and requests for reprints to Dr. Cynthia C. Gadbury-Amyot, School of Dentistry, University of Missouri-Kansas City, 650 E. 25th Street, Kansas City, MO 64108; 816-235-2054; amyotc@umkc.edu.

Keywords: dental education, active learning, technology, clickers, lecture capture, pediatric dentistry

Submitted for publication 2/5/16; accepted 5/3/16

The past 20 years in dental education have seen a new emphasis on the need for dental students to learn the critical thinking, problem-solving, and self-directed assessment-seeking strategies necessary for professional practice in today's environment.¹⁻⁵ Earlier, the Gies report's argument in 1926 for a scientifically based curriculum that promoted scientific principles as the basis for clinical practice depended on the development of critical thinking and problem-solving skills and an orientation for lifelong learning.⁶ Recently, Pyle's overview of curricular change over the past 75 years led her to conclude that "curricular modifications focused on student learning vs. teaching have created some of the most important advances in dental education in the recent years" (p. 96).⁷ While noting that more progress is needed, her

overview, along with Hendricson's review of educational methodologies and Haden et al.'s survey of curriculum change,^{8,9} demonstrated the shift in dental education toward learning-centered strategies that focus on competency-based assessment and active learning methodologies.

A substantial body of educational research now exists around the concepts of active versus passive learning.¹⁰ Recent research builds on the strong theoretical base established in the late 1800s by the work of John Dewey and the developmental psychologists and constructivist theorists Jean Piaget and Lev Vygotsky.¹¹⁻¹³ Their work emphasized the need for individuals to construct their own meaning of new knowledge by presenting content in a way that allows the student to relate the information to

prior knowledge and experiences. In other words, the importance of having students interact or engage in learning is essential to the learning process. Another theory supported by this body of research is that learning is a social activity, and as such, the influence of social interaction and collaboration on the learning process should be taken into consideration when constructing learning environments. Active learning exercises such as team-based assignments, case studies, debates, and self-reflection encourage student engagement.¹⁴ Reflection encourages students to explore their attitudes, as well as fostering their motivation to acquire knowledge and enhance skills. The use of technology, such as audience response systems (clickers), has also been found to enhance the teaching and learning environment by promoting student engagement and active learning.¹⁵⁻¹⁷

A more recent active learning strategy that has received considerable attention is the flipped classroom. The idea of a flipped classroom received attention when Aaron Sams and Jonathan Bergmann posted a YouTube video on December 16, 2010 titled "The Flipped Classroom."¹⁸ In 2012, Bergmann and Sams published *Flip Your Classroom: Reach Every Student in Every Class Every Day*.¹⁹ A typical flipped classroom strategy is for instructors to prerecord lectures and post them online for students to watch on their own so that class time can be dedicated to student-centered learning activities. The idea is for faculty members to incorporate content for class that will require students' engagement with material and encourage critical thinking and problem-solving. This student-centered model requires that students be responsible for coming to class with a basic understanding of the materials, so that they can fully participate in class discussion and activities. Content acquisition is self-paced and self-guided, enabling students to control when and how much content they view. Faculty members serve as facilitators of learning by organizing content, developing interactive experiences, challenging students to think, and providing expert insight and feedback. Bergmann and Sams posit that rich, open-ended experiences within the classroom equip students for success by fostering critical cognitive development and promoting innovation through collaboration.¹⁹

An implementation of the flipped classroom model in a predoctoral dental course was recently described by Park and Howell.²⁰ Their study of a second-year dental anatomy course with 36 students involved student feedback obtained from a single

survey collected at the end of the course. Their report highlighted the significant impact the course had on faculty members as they recorded lectures and prepared quizzes and active learning exercises. The study found faculty resistance to implementation of the model, particularly when faced with an increased workload in regard to time and effort required to develop new lectures and interactive classroom activities. However, the authors further reported that, after initial implementation, faculty feedback was more encouraging and positive. In the students' feedback, the flipped classroom format was reported to be more fun, interactive, and collaborative than the traditional lecture format. The students reported some technical difficulties with the system and that at times the small group discussions could be disorganized.

Another study, conducted by Shapiro et al., found that using interactive online modules to teach dental concepts, such as how to recognize and report child abuse, was as effective or more so than traditional lecture-based learning.²¹ That study's online module consisted of 50 minutes of instruction and involved 72 dental students. The results showed that the interactive online training module was statistically more effective than the lecture-based method in teaching students how to recognize child abuse and neglect and steps involved for reporting. However, while the students reported that the online training module was helpful, they did not prefer it as a replacement for the lecture-based approach.

The aim of our study was to explore student and course director experiences with the redesign of a traditional lecture-based course into a flipped classroom for teaching didactic content in pediatric dentistry to second-year dental students. The course redesign sought to improve students' learning experience, actively engage students in course content to stimulate higher order thinking through applied learning, and increase faculty satisfaction through new teaching strategies. The research questions were as follows: 1) What was overall student satisfaction with the course as measured by the school's student evaluation process and an author-developed questionnaire? 2) Did students report increased engagement through active learning as measured by the questionnaire? 3) What effect did the new course design have on course grades as measured by performance on midterm and final examinations? 4) Did the course redesign result in increased self-reported satisfaction for the course director?

Materials and Methods

This study was approved by the Institutional Review Board of the University of Missouri-Kansas City (UMKC IRB 14-020). The study sample consisted of predoctoral dental students enrolled in a pediatric dentistry didactic course at the University of Missouri-Kansas City in the spring of 2014 (n=106; SP14) and the spring of 2015 (n=106; SP15).

For the study, we developed a 20-item questionnaire designed to capture student perceptions of the flipped classroom design, based on previous similar research.¹⁹⁻²³ Response options on a Likert scale from 1=strongly disagree to 5=strongly agree were used for the majority of the questions. For the question on assigned readings, a scale of 1=never to 5=all of the time was used. A global question about overall rating of the course used a scale from 1=poor to 5=excellent. The first eight questions were designed as pre-post questions to measure students' perceptions at two points in time (start of the course and end of the course). Twelve additional questions were developed for the post-course evaluation to further explore students' perceptions of the flipped classroom experience at the conclusion of the course. Two faculty members with backgrounds in teaching methodology and online education reviewed the questionnaire, and minor modifications were made to increase clarity.

The pediatric dentistry didactic course is taken during the spring semester of the students' second year of a four-year curriculum. In the old course format, each topic was delivered in a traditional live lecture format. Course goals and objectives for each presentation were documented in the course syllabus. The PowerPoint presentations used in the lectures were available to students in the form of handouts loaded on the course Blackboard website. The majority of the lectures were developed and delivered by the course director (BSB, who was the study's principal investigator [PI]). A few guest lectures were delivered by other full-time faculty members in the pediatric department. Grades for the course were determined by averaging the midterm and final examination scores. Exams consisted of 50 multiple-choice questions designed to encourage critical thinking skills. Approximately 30% of the test items were clinical case-based scenarios.

For the new course design, lectures were developed using Tegrity (lecture capture) software and made available for student viewing in Blackboard at

the start of the semester. At the course orientation, students were instructed to follow the course syllabus, which involved a weekly schedule for assigned readings and lecture review. In alignment with the old course format, the PowerPoint presentations that accompanied the video lectures were available as handouts for each presentation, with goals and objectives for each in the course syllabus. The dedicated class time was retained, so should students choose, they could use the designated time to work on asynchronous assignments such as viewing the recordings.

In the new course design, mandatory attendance for four 50-minute didactic sessions during the semester was expected and recorded by the course director. During the mandatory didactic sessions, the course director utilized the TurningPoint Technologies automated response system (ARS) or clickers (Turning Technologies LLC, Youngstown, OH, USA) to engage students regarding topics scheduled for review. Presentations were developed that included clinical scenarios demonstrating and exploring the impact of the information delivered in the captured Tegrity presentations. The ARS was used to gauge student understanding of clinical concepts and to encourage discussion of such concepts.

To maximize student participation in the evaluation, paper and pencil questionnaires were used, and students submitted completed questionnaires anonymously in a collection box. Student feedback on the initial course redesign in spring 2014 was used to further revise the course for spring 2015. Changes included the addition of two quizzes administered during the live discussion sessions that counted for 10% of the overall grade for the course; addition of another discussion session primarily based on clinical cases pertaining to topics covered in the previous weeks' online presentations; and modified exam questions designed to present cases in a more succinct manner to test concepts.

An independent-samples t-test was conducted to evaluate differences between SP14 and SP15, and descriptive statistics were used to analyze the pre/post questions. Statistical significance was set at 0.05.

Results

Responses on the pre- and post-course questionnaires resulted in an overall response rate of 94.9% on the pre questionnaire and 84% on the post questionnaire. The numbers of respondents for

the spring 2014 (SP14) course were 100 on the pre questionnaire and 84 on the post questionnaire. The numbers of respondents for the spring 2015 (SP15) course were 101 on the pre questionnaire and 94 on the post questionnaire.

Regarding research question one about overall student satisfaction with the course, the overall mean (standard deviation [SD]) was 3.68 (1.150) on a five-point scale. Because changes were made for the SP15 course based on feedback from SP14, statistics for the two semesters were also examined separately on the overall rating question. The means (SD) were as follows: SP14=3.04 (1.214); SP15=4.24 (0.714). An independent-samples t-test was conducted to evaluate differences between SP14 and SP15 on the overall rating question. The test was significant, $t(129.07)=-7.94, p<0.05$.

To further explore student satisfaction, the pre/post question “I prefer the traditional lecture format course” was evaluated (Table 1). While there were no significant differences overall, comparison between

SP14 and SP15 again resulted in a significant difference, $t(367.91)=2.33, p<0.05$. Descriptive statistics for the additional questions on the post-course questionnaire are shown in Table 2. The greatest perceived advantage overall was acknowledgment that the knowledge and skills developed in the course were relevant to the students’ future. Similar to the pre/post questions, there were significant differences between SP14 and SP15 on the post-course questions, with SP15 again reporting greater satisfaction with the flipped classroom design.

Research question two examined whether students reported increased engagement through active learning as a result of the course redesign. Three of the pre/post questions were designed to capture students’ perceptions on engagement: 1) Interactive, applied in-class activities greatly enhance/enhanced my learning; 2) I participate/participated and engage/engaged in discussions in class; and 3) In-class discussions of course concepts with my peers greatly enhance/enhanced my learning. There

Table 1. Pre/post question means and standard deviations (SD) for students in spring 2014 (SP14) and 2015 (SP15)

Pre Question/Post Question	SP14		SP15	
	Mean (SD)	Mean Difference	Mean (SD)	Mean Difference
Lectures greatly enhance my learning/ Prerecorded lectures greatly enhanced my learning.	Pre: 3.40 (0.92) Post: 2.98 (1.24)	-0.424*	Pre: 3.54 (1.10) Post: 3.72 (0.95)	0.180
Learning key foundational content prior to coming to class greatly enhances/ enhanced my learning of course material in class.	Pre: 3.39 (1.03) Post: 3.00 (1.01)	0.390*	Pre: 3.45 (1.13) Post: 3.92 (0.93)	0.479*
Interactive, applied in-class activities greatly enhance/enhanced my learning.	Pre: 3.36 (1.11) Post: 3.50 (1.01)	0.140	Pre: 3.63 (1.01) Post: 4.03 (0.95)	0.399*
I participate and engage/participated and engaged in discussions in class.	Pre: 2.49 (0.96) Post: 3.68 (0.84)	1.189*	Pre: 2.87 (1.07) Post: 3.56 (0.94)	0.693*
In-class discussions of course concepts with my peers greatly enhance/enhanced my learning.	Pre: 3.17 (1.01) Post: 3.33 (0.90)	0.163	Pre: 3.18 (1.08) Post: 3.65 (0.96)	0.467*
Assigned readings from textbooks or articles enhance/enhanced my learning.	Pre: 2.43 (1.03) Post: 2.01 (0.96)	-0.418*	Pre: 2.21 (1.08) Post: 1.99 (0.97)	-0.221
I prefer the traditional lecture format course.	Pre: 3.15 (0.95) Post: 3.15 (1.49)	-0.005	Pre: 3.01 (1.10) Post: 2.72 (1.10)	-0.286
I read assigned readings prior to coming to class.	Pre: 2.13 (0.76) Post: 2.05 (0.97)	-0.082	Pre: 2.20 (0.87) Post: 2.36 (1.23)	0.164

Note: Pre questions refer to a traditional face-to-face lecture format; post questions refer to revised course including prerecorded lectures using Tegrity. Response options ranged from 1=strongly disagree to 3=neutral to 5=strongly agree.

*Significantly different at 0.05 level

were significant differences between the pre and post results on all three questions for SP15 (Table 1). The SP14 group showed significant differences only on the question about participating and engaging in discussions in class. While student perceptions were statistically higher at the completion of the course, they still remained in the neutral (mid to high 3) range on the scale.

On the post course questionnaire, students were asked to choose up to three things they liked best about the flipped classroom from a list of perceived advantages we developed from prior studies (Table 3). While the students' greatest perceived advantage

was availability and access to online content and course materials, the second highest was clickers to test knowledge in preparation for exams. The third highest perceived advantage was in-class group discussion. Collectively, these data show that students were actively engaging in the flipped classroom.

Research question three addressed the effect of the course redesign on course grades. Course grades (A, B, or C) for two years prior to flipping the course and for the SP14 and SP15 years are shown in Table 4. The results showed that incorporation of the flipped classroom design led to a far higher percentage of students earning an A for the course.

Table 2. Level of agreement with post-course survey items, by mean rating (standard deviation) for students in spring 2014 (SP14) and 2015 (SP15)

Item	SP14	SP15
The knowledge and skills I developed in this course are relevant for the future.	4.05 (0.74)	4.57 (0.66)*
The instructor encouraged active student participation in class.	3.92 (0.82)	4.27 (0.85)*
Active student engagement was consistently encouraged by the instructor.	3.79 (0.87)	4.11 (0.77)*
I felt confident in my ability to apply the knowledge and skills developed in this course.	3.31 (0.85)	4.09 (0.74)*
Learning materials and resources were helpful.	3.14 (0.92)	3.91 (0.83)*
I had to prepare for class in order to be successful.	3.07 (1.14)	3.80 (1.00)*
Teaching and learning methods in the flipped classroom promoted understanding and application of key concepts.	3.04 (1.05)	3.70 (0.84)*
The course structure assisted in overcoming learning difficulties associated with language delivery limitations.	3.12 (1.06)	3.53 (0.89)

Note: Response options ranged from 1=strongly disagree to 3=neutral to 5=strongly agree.

*Significantly different at 0.05

Table 3. Perceived advantages of flipped classroom design, by number and percentage of total student respondents in spring 2014 (SP14) and 2015 (SP15)

Advantage	SP14 (N=84)	SP15 (N=94)
Availability and access to online content and course materials	61 (33.2%)	78 (40%)
Use of clickers to test knowledge in preparation for exams	29 (15.8%)	75 (38.5%)
In-class group discussion	37 (20.1%)	48 (24.6%)
Enhanced communication	14 (7.6%)	16 (8.2%)
Group collaboration	12 (6.5%)	9 (4.6%)

Note: Participants were allowed to choose multiple advantages.

Table 4. Average final grades earned pre and post flipped classroom format

Cohort	A	B	C
Spring 2012 (pre-flip) n=106	31 (29%)	64 (60%)	11 (10%)
Spring 2013 (pre-flip) n=104	32 (31%)	61 (59%)	11 (10%)
Spring 2014 (post-flip) n=106	86 (81%)	17 (16%)	3 (3%)
Spring 2015 (post-flip) n=106	82 (77%)	24 (23%)	0

Note: Percentages may not total 100% because of rounding.

Table 5. Emergent categories from open-ended survey questions: number of comments per category per year and representative comments

Category	SP14 (106 students)	SP15 (106 students)
Things students did not like		
Handouts	n=20 (18.8%) "Quality of PowerPoint pdf was not clear." "The notes were difficult to see; ppp were fuzzy, poor resolution." "The pages of six slides per pare are very hard to read; info on charts or pictures inserted into the slides is completely illegible."	n=2 (1.8%)
Prefer traditional lecture	n=7 (6.6%) "I prefer the traditional lecture and have a hard time listening on the computer." "I like traditional class better." "I learn better in the classroom."	n=8 (7.5%) "It's hard to make myself watch Tegrity. I like listening to a traditional lecture." "I would rather sit in class and listen to the instructor in person." "I enjoy being at lectures more to have real teacher interaction."
Procrastination	n=8 (7.5%) "Encourage procrastination from not having class each week." "Hard to stay motivated to self-learn w/ all of the other courses." "My main problem was making sure I took the time to watch the lectures on my own time." "Easy to slack off and get behind."	n=2 (1.8%) "It was easy to procrastinate studying for exams." "Promotes me to be a little lazy."
Technical issues	n=5 (4.7%) "Clickers don't work regularly." "It [Tegrity] doesn't work well with different Internet browsers." "The use of clickers is inconvenient as they do not work always."	n=1 (0.94%) "Technical issues that prevented me from seeing a couple of the lectures."
Exams	n=5 (4.7%) "Overly difficult exams for no reason; pedo should be straightforward, not based on trick questions." "Test questions too long." "Didn't know what to expect on exams."	n=0

(continued)

Thematic analysis was used to examine responses to the two open-ended questions asking participants to list three things they did not like about the flipped classroom and three ways the flipped classroom could be improved.^{24,25} Table 5 lists the emergent themes with representative comments. Not surprisingly, the emergent themes were similar for the two questions. Also evident was the difference in the feedback between responses in SP14 and SP15, with the SP14 responses noting more issues with the flipped classroom design. This feedback was used to

make improvements in the learning experience for the following year.

The final research question addressed the course director's experience, specifically whether transitioning to a flipped classroom resulted in increased satisfaction. To address this question, the PI reflected on what effect this course redesign had on her personally and shared these thoughts through self-report. The PI has served as director of the second-year course in pediatric dentistry for 28 years using a traditional lecture format for 26 of

Table 5. Emergent categories from open-ended survey questions: number of comments per category per year and representative comments (*continued*)

Category	SP14 (106 students)	SP15 (106 students)
Suggestions for improvement		
Handouts	n=18 (16.9%) "Handouts posted on Blackboard rather than Tegrity at 1 slide per page so notes can be taken more easily and information can be read." "I print off all of my notes: many of the lectures had illustrations that were really fuzzy on paper and even difficult to read when zoomed in on the computer." "My only recommendation could be to have less distorted slides. Some of them look scanned and were hard to read."	n=4 (3.7%) "Please upload lecture notes directly to Blackboard; use format of one slide/pg."
Prefer traditional lecture	n=10 (9.4%) "Have regular class." "Go back to traditional lecture." "Normal lecture would be more beneficial."	n=1 (.9%) "Do not do them [prerecorded lectures]. . . . It is hard to want to learn when there is no teacher to teach."
Exams	n=7 (6.5%) "If the professors practiced questions that were more like the test during the discussions, we could apply the knowledge in the way they expect us." "PowerPoints didn't reflect exams." "Exam questions needed to be shortened and clarified better."	n=0
Positive about flipped classroom	n=0	n=5 (4.7%) "Discussions were great. . . . These were fun/enlightening." "Enhanced my learning because I could watch lectures on my own time." "I like the way the class was run."
Technical issues	n=3 (2.8%) "Make it work w/ different Internet browsers." "Present the lectures on Blackboard also . . . so that they can ensure the lectures will be easily accessed."	n=0

Note: The "Things Students Did Not Like" question (#19) was worded: Please list up to three things that you did not like about the flipped classroom. The "Suggestions for Improvement" question (#20) was worded: Please list up to three ways that the flipped classroom could be improved. The n refers to total number of comments in that category. Percentage refers to percentage of comments in that category for that year.

SP14=students in spring 2014; SP15=students in spring 2015

those years. Besides the personal satisfaction from completing a course redesign, the PI experienced increased student-faculty interactions in the flipped classroom and believed it created a more enjoyable environment for teaching a large class of 100 students. A second source of satisfaction for the PI related to her role as chair of pediatric dentistry.

Flipping the classroom provided a venue for engaging departmental faculty members in the world of online teaching and learning in a comfortable and non-threatening environment. The department intends to maintain the flipped classroom design as a result of this study.

Discussion

Two of the aims of this investigation were to determine how a flipped classroom course design impacted student satisfaction with the course and if such a change encouraged engaged learning. The students rated the majority of the questions, both pre and post, in the neutral category (3 on the five-point scale), indicating some ambiguity regarding their overall satisfaction with the flipped classroom design. In the transition from faculty-centered to learner-centered courses, students are pushed to take on more active and responsible roles. The results of this study may be similar to Boud's finding in 1981 of students' resistance to taking greater responsibility for their own learning.²⁶ A more recent study suggested that students who expect to take a passive role in the educational environment may be inclined to resist new methods of teaching and learning when those expectations are not met.²⁷ In that study, Keeney-Kennicutt et al. emphasized the importance of faculty members' being attentive to student resistance and demonstrating a willingness to respond to student concerns. Our study made use of students' recommendations to revise our course in the second year, and as a result student perceptions significantly improved from initial implementation in SP14 to the revised version in SP15.

There was also a striking improvement in the grades earned by students in the flipped classroom design (Table 4). These changes may be due to a number of factors. First, the incorporation of case discussions into the interactive sessions may have increased the students' readiness to think critically when answering case-based questions on the exam. Due to the change in course format, the course director used the interactive sessions to emphasize key aspects of case analyses. In the previous lecture-based course, faculty members were intent on covering content with less of an emphasis on interactive strategies such as case analyses. Second, the incorporation of graded quizzes into the overall grading schema for the course may also have contributed to the positive change in grade distribution. An argument could be made that the quizzes provided formative assessment opportunities, which had been missing in this course prior to the course redesign. At the UMKC School of Dentistry, most agree that the D2 year is particularly difficult. Adding graded quizzes with clickers in effect reduced the impact of midterm and final examination scores on the overall grade earned, making those examina-

tions less high stakes. Third, the overall rationale for the course redesign was to engage students more actively in the subject matter, based on educational research showing that active engagement is necessary for learning. The higher grades may indeed reflect greater learning on the part of the students as a result of the active learning strategy.

Flipping a classroom involves a much greater engagement by both faculty members and students with technology. Much as Park and Howell reported in their study of the development and implementation of a flipped classroom in a dental anatomy course,²⁰ the students in our study reported technical difficulties. However, the second year with the flipped classroom was much smoother as a result of the course director's concerted effort to address the feedback from the first-year cohort (Table 5).

The final aim of the study was to determine if the course director reported an increase in satisfaction with the course performance as compared to the traditional lecture format. Although the amount of time and effort needed to integrate technology into the course was fairly substantial in year one, the subsequent year of the course went significantly better. These results are consistent with findings in Park and Howell's study in which faculty feedback was more positive as time went on.²⁰ Flipping the classroom encouraged a long-time clinician to expand her experience with technology for teaching and learning, invigorated her desire to continue to grow and develop as an academician, and enhanced her career satisfaction with renewed energy to continue to teach.

Limitations to this study include that it was carried out in one dental school, and therefore the results may not be generalizable. A second limitation involves the issue of self-report when using survey research to collect data. As dental education continues to adopt new strategies for teaching and learning, such as the flipped classroom, it will be important to expand research to explore the impact on faculty and students. Directions for future research can be found in Commission on Dental Accreditation (CODA) standard 1-2, the intent statement for which states: "Assessment, planning, implementation, and evaluation of the educational quality of a dental program that is broad-based, systematic, continuous, and designed to promote achievement of program goals will maximize the academic success of the enrolled student."⁵ Future research will involve ongoing data collection and examination of the impact of course redesign on student and faculty outcomes over time as suggested by standard 1-2.

Conclusion

For nearly three decades, the PI from the UMKC School of Dentistry Department of Pediatric Dentistry has delivered didactic information to second-year dental students using a lecture-based course design. While this classic didactic delivery system has historically been used to teach clinical concepts to dental students, it had become increasingly evident over the past decade that other avenues of instruction were needed to successfully engage today's students. This study highlighted the experiences of integrating a flipped classroom for delivering didactic material to second-year students. The results of this study showed that the students did not readily take to a course redesign that required greater active and self-directed learning; ongoing assessment of the impact of the course redesign on student and faculty perceptions was necessary to appropriately respond to feedback by incorporating revisions in the course; and student learning outcomes (course grades) improved in the flipped classroom design.

REFERENCES

1. Pyle M, Andrieu SC, Chadwick DG, et al. The case for change in dental education. *J Dent Educ* 2006;70(9):921-4.
2. Haden NK, Andrieu SC, Chadwick DG, et al. The dental education environment. *J Dent Educ* 2006;70(12):1265-70.
3. Albino JE, Young SK, Neumann LM, et al. Assessing dental students' competence: best practice recommendations in the performance assessment literature and investigation of current practices in predoctoral dental education. *J Dent Educ* 2008;72(12):1405-35.
4. Field MJ, ed. *Dental education at the crossroads: challenges and change*. An Institute of Medicine Report. Washington, DC: National Academies Press, 1995.
5. Commission on Dental Accreditation. *Accreditation standards for dental education programs*. Chicago: American Dental Association, 2013.
6. Gies WJ. *Dental education in the United States and Canada*. New York: Carnegie Foundation for the Advancement of Teaching, 1926.
7. Pyle MA. New models of dental education and curricular change: their potential impact on dental education. *J Dent Educ* 2012;76(1):89-97.
8. Hendricson WD. Changes in educational methodologies in predoctoral dental education: finding the perfect intersection. *J Dent Educ* 2012;76(1):118-41.
9. Haden NK, Hendricson WD, Kassebaum DK, et al. Curriculum change in dental education, 2003-09. *J Dent Educ* 2010;74(5):539-57.
10. Prince M. Does active learning work? A review of the research. *J Eng Educ* 2004;93(3):223-31.
11. Piaget J. *Biology and knowledge*. Chicago: University of Chicago Press, 1971.
12. Vygotsky LS. *Mind in society: the development of higher psychological processes*. Cambridge: Harvard University Press, 1978.
13. Dewey J. *The child and the curriculum*. Chicago: University of Chicago Press, 1906.
14. Gadbury-Amyot CC, Simmer-Beck M, McCunniff M, Williams KB. Using a multifaceted approach including community-based service-learning to enrich formal ethics instruction in a dental school setting. *J Dent Educ* 2006;70(6):652-61.
15. Sateesh KM, Saylor-Boles CD, Rapley JW, et al. Student evaluation of clickers in a combined dental and dental hygiene periodontology course. *J Dent Educ* 2013;77(10):1321-9.
16. Caldwell J. Clickers in the large classroom: current research and best-practice tips. *CBE Life Sci Educ* 2007;6(1):9-20.
17. Cain J, Black EP, Rohr J. An audience response system strategy to improve student motivation, attention, and feedback. *Am J Pharm Educ* 2009;73(2):1-7.
18. Sams A, Bergmann J. *The flipped classroom*. YouTube, 2010. At: [youtube/2H4RkudFzlc](https://www.youtube.com/watch?v=2H4RkudFzlc). Accessed 13 Jan. 2016.
19. Bergmann J, Sams A. *Flip your classroom: reach every student in every class every day*. Washington, DC: International Society for Technology in Education, 2012.
20. Park SE, Howell TH. Implementation of a flipped classroom educational model in a predoctoral dental course. *J Dent Educ* 2015;79(5):563-70.
21. Shapiro MC, Anderson OR, Lal S. Assessment of a novel module for training dental students in child abuse recognition and reporting. *J Dent Educ* 2014;78(8):1167-75.
22. Kirch C. *Flipping with Kirch*. 2015. At: flippingwithkirch.blogspot.com/. Accessed 13 Jan. 2016.
23. Pierce R, Fox J. Vodcasts and active-learning exercises in a "flipped classroom" model of a renal pharmacotherapy module. *Am J Pharm Educ* 2012;76(10):196.
24. Creswell J. *Research design: qualitative and quantitative approaches*. London: Sage, 1994.
25. Patton M. *Qualitative research and evaluation methods*. 3rd ed. London: Sage, 2002.
26. Boud D. *Developing student autonomy in learning*. London: Kogan Page, 1981.
27. Keeney-Kennicutt W, Gunersel AB, Simpson N. Overcoming student resistance to a teaching innovation. *Int J Scholarship Teach Learn* 2008;2(1):1-26.