Educators Guiding Students With Different Cognitive Levels Through Complex Assignments At Any Educative Level

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Students often need guidance to recognize the techniques necessary to complete complex assignments. The challenge that educators face is choosing the appropriate teaching method for students of different cognitive levels. We utilized the critical thinking framework and repetitive practice models in preclinical and clinical courses. These forms of teaching have been utilized and acknowledged in numerous disciplines for years. For our exercise, we started by administering a brief survey to assess the students perceptions, learning preferences and confidence levels. Next we assessed the students' cognitive levels by utilizing 3 calibrated cases and graded the responses with a 1-5 point Likert scale. This information revealed critical thinking and repetitive practice models yield maximum results. Secondly, the students were observed in a large group setting while utilizing critical thinking components to discern vital and non-vital information. Once all vital information was collected, educators then guided the students with the critical thinking framework as they completed the assignment. Constant reflection on decision making was modeled until the student attained a favorable outcome. The last component involves students implementing the repetitive practice model of repeating the maximum outcome path to the student advances on the mastery scale of novice to expert. Educator guidance was needed to facilitate student growth through the stages. Students' perceptions, learning preferences and confidence levels were assessed with a brief survey and results compared to the beginning. These teaching techniques were applied with successful results in our class. This model can be applied in different classes with students of varying cognitive levels with minimal modifications.

Introduction

Students entering an educational classroom represent an array of different cognitive levels. Exposure to life situations and how each student handled those situations, dictates what learning skills and cognitive level each student possesses (Jensen, 2009). Educators face the daunting question of "How do you teach the same concepts and skills to students with diverse abilities and interests? Different learning profiles? And how do you do that in real classrooms, with limited time?" (Finley, 2017). Choosing the appropriate instruction style for each student is vital in attaining

maximum results with any assignment. As the student population rapidly changes, this study sought out to establish framework guidelines a student can follow for effective decision making that transforms knowledge into ultimate performance with any educative and cognitive level. Educators must know and understand how to assess their student needs and navigate the framework guidelines effectively in order to achieve success with each assignment objective. Educators must acknowledge no two students are the same and that every person has a different learning style. A teacher's instruction style, therefore, can greatly impact a student's ability to learn and comprehend (University of San Diego, 2019).

The authors' institution, The University of Louisville, is committed to utilizing the Paul-Elder framework to critical thinking with practice and reflection. Studies have shown that when institutions invest in faculty development, the educator is more likely to teach those same learning techniques to their students and continue to develop a deeper understanding and application of these techniques during their educative process at the represented institution. Intuitively, it makes sense that professors who spend time developing their teaching skills will become more effective instructors—and that will eventually translate to better student outcomes (Flaherty, 2016). All of the authors of this study apply the critical thinking process with practice and reflection in their courses and teach the application guidelines to students on a daily basis in our patient care clinics. The School of Dentistry at this university requires students to participate in a critical thinking module and lecture class in their first year of dental school. The students complete a pre-test and exercise assessing their understanding of critical thinking components and application. The pre-test is followed by a lecture explaining the Paul-Elder Framework concept with cases of application reviewed. The students then complete a post-test to compare advancements in their understanding of key topics and the reflective-practice framework usage. Using a pretest-posttest and case study design, the authors attempted to formulate a guide for students on different cognitive levels to utilize while completing complex assignments.

Literature Review

Choosing the Appropriate Project or Instructional Style For Complex Assignments

Educators when choosing the appropriate project or instructional style have many influencing factors to consider. Some of the influencing factors may include class size, amount of grading, teacher comfort level and education topic. Monks and Schmidt (2010) conducted a study comparing the impact of class size and number of students on outcomes in higher education. This study concluded "both class size and the total number of students that a faculty member is responsible for teaching have a negative impact on the self-reported outcomes of amount learned". The IDEA Center, a nonprofit organization whose mission is to serve colleges and universities committed

to improving learning and teaching, has categorized class size as small (10-14), medium (15-34), large (35-49), and very large (50+) (Benton and Pallett, 2013). Even though this research showed that student engaging projects and smaller group size is most beneficial in attaining student learning outcomes, lecturing still remains the most frequent teaching method utilized in all class sizes. Secondly, educators consider the amount of grading when choosing the project. Grading tip #5 for New Teachers suggests - Don't assign busywork that takes your whole weekend to grade (Marshbank, 2018). According to this study (Marshbank, 2018):

> Only give students impactful work that develops their skill sets. Just as an educator wants to use time grading assignments that matter, students want to complete work that matters. By avoiding assigning meaningless work, you can ensure that everyone's time is spent optimally. (p. 3)

Thirdly, let's look at a teachers comfort level. Does a teacher teach the way they were taught? Won't we always teach in the areas we feel most comfortable? These questions were answered in a study conducted by Stephanie Elizabeth Cox at Brigham Young University (2014). Cox found that teachers do not teach the way they themselves were taught. Most of the teachers (N=33, 77%) stated they teach the way they preferred to be taught when they themselves were in school. The teachers tried to follow the example of teaching techniques of good teachers they encountered while in school and not teaching styles used by bad teachers. Teachers also stated (N=30, 70%) they like to think they teach the way students learn best. Lastly, let's address the education topic. Education topics are highly influential when choosing the educational techniques utilized in the classroom. The way we teach a surgical procedure in the medical profession is drastically different then the way we teach a student how to speak another language. Even though topics can be drastically different they have one influencing factor in common- technology. Technology continues to change the way we teach our students. Considering digital technologies' widespread availability and influence in everyday life, the use of different technologies for educational purposes is an important subject for teachers to consider when choosing a teaching technique (Flanagan & Shoffner, 2013). Years ago a foreign language was taught by lecturing in the classroom and reviewing picture flash cards, while repeating and writing the name of the object. The latest advancement with classroom teaching techniques involves interactive programs where the students receive instant feedback on their assignment answers, therefore maximizing the student's educational experience. Medicine has always perplexed educators on what approach is best to teach students on complex and integrative procedures. One teaching method that is receiving increasing interest in the medical field is computer-integrated simulation (Rauen, 2004). This study found that simulation can be used to teach theory, assessment, technology, pharmacology, and skills through application and integration of knowledge, skills, and critical thinking. No matter the topic, an educator needs to understand the influence technology has in the classroom and daily experiences, especially with complex assignments.

Students With Different Cognitive Levels

The Berkeley Center for Teaching & Learning (2019) asked the questions, What do you do when your class is divided between students who easily master the material and students who continually struggle? Or when you see that a few students find the material easy, are bored, and yearn to be challenged, while others aren't "getting it"? The goal of getting all students on the same level is unrealistic. Students learn differently and at their own pace. How can we bring the student cognitive levels closer together and accomplish course objectives? According to the American Psychological Association (Braebeck, Jeffrey & Fry, 2019):

> Achievement gaps often exist because of unequal opportunities for students to engage in appropriate deliberate practice rather than unequal learning abilities, therefore, deliberate practice can also provide a bridge over the gaps that exist between different achievement levels.

Deliberate practice depends on assessing, repeating the task and reflecting on results to be successful therefore, expanding and increasing the students' cognitive levels. The claim of success when utilizing the deliberate practice framework is that such behavior is necessary to achieve high levels of expert performance (Campitelli & Gobet, 2011). This repetitive practice advances a student from novice to expert. An expert and novice differs in the amount and structure of information stored in their long-term memories. This cognitive difference occurs in part largely because of the amount of deliberate practice in which each student has engaged (Cantor & Engle, 1993). An educator in an academic setting needs to acknowledge the variety of student backgrounds and encourage students to deliberately practice to increase mastery levels in any classroom assignment.

Guiding Students At Any Educative Level

Much of the literature regarding guiding students at different educative levels was about applying the Paul-Elder critical thinking framework and reflection. Critical thinking is considered a necessary learning outcome for all students and essential for academic and career success (Ralston & Bays, 2015). Elmansy (2017), acknowledges the critical thinking process is based on three main stages: observe the problem to build rational knowledge, ask questions to analyze and evaluate data, and find answers to the questions that can be formulated into a solution for the problem. These stages are translated into six steps: knowledge, comprehension, application, analysis, synthesis and evaluate. Critical thinking is that mode of thinking-about any subject, content, or problem- in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them (Paul & Elder, 2001). Critical thinking requires deliberate practice from the student with educator guidance. At the start, the student will be unsuccessful navigating the critical thinking framework process without application guidance and feedback from the teacher. Once the student becomes

familiar with how the process works, the student will then be able to practice the critical thinking process to any situation they may encounter on their own. The final educative exercise necessary when guiding students at any educative level is the process of reflection. Providing opportunities for teachers and students to reflect in the context of supportive and solution-focused environments leads them to make strides toward professional goals, builds self-efficacy, establishes long-term growth, and ultimately can result in higher student achievement (Marvel, 2018). The educator's knowledge and confidence level in using the framework-reflective model is the beginning of the student educative application process. If done correctly, a teacher may apply this model at any educative level with maximum and successful results.

Methods

Study Objective

The objective of the study was to implement a condensed reference guide on the topic of clinic prescription writing and to attain feedback on the effectiveness of its utilization by students during the four years in dental school. We utilized critical thinking, deliberate practice models and reflection as our teaching techniques, while applying the reference guide. We feel that utilizing a condensed prescription writing reference guide along with these teaching techniques will increase patient quality of care, decrease student mistakes and maximize student outcomes in preclinical and clinical courses.

Study Design

This study design included pre-survey, pre-exercise, lecture, post-exercise, and post-survey design to examine the effectiveness of the process of writing prescription medications for the clinic utilizing a condensed 11 category reference guide. The Institutional Review Board at the university approved this research.

Participants

All students completed the critical thinking pre-post assessment and competency testing in their first year of dental school (D1) prior to this study. The survey and prescription writing exercise was administered to the D1-D4 students at the end of the Spring Semester with a projected maximum sample size of N=480. Participation in the study was anonymous and voluntary, and there was no grade attached to either the survey or exercise.

Instruments

The study began with the student completing three blank case based prescriptions followed by a brief survey. The survey consisting of 17 questions were then answered

by each student. The case prescriptions and survey were followed by a one hour traditional classroom instruction utilizing a condensed 11 category reference guide on writing prescription medications for the dental student during their 4 years in dental school. The teaching techniques utilized for the classroom lecture included critical thinking, deliberate practice models and reflection. Following the lecture, students were asked to complete the same three blank case prescriptions and survey taken in the beginning of class. Survey responses were converted to a 5 point Likert point scale of "strongly disagree" , "disagree", "neither agree nor disagree", "agree" to "strongly agree" for comparison. The three prescription case exams were graded and converted to a percentage for comparison with 100% the maximum achievable score. There are no demographic information questions asked on the survey, so students are not identified and the study carries minimal risk to the students.

Results

Students agreed to participate in this study at the end of the spring semester 2018. Out of the 17 questions, 3 survey questions were used for comparison addressing the 3 teaching techniques. Of the three techniques measured on the survey, all 3 items showed a significant difference from the pre-survey to post-survey scores. Question #13 examined student understanding and comprehension in using the clinical reference guide (see Figure 1). The dependent within subjects t-test determined a significant difference ($p<0.05$) in pre [3.0 ± 1.1] and post [4.3 ± 0.8] with intervention mean responses on question #13 (N=342). Student comfort level utilizing the deliberate practice method were examined in question #14 (see Figure 2). The dependent within subjects t-test determined a significant difference ($p<0.05$) in pre [3.2 ± 1.0] and post [4.5 ± 0.7] intervention mean responses on question #14 (N=345). Figure 3 demonstrates changes in student learning in their application of content through reflection. The dependent within subjects t-test determined a significant difference ($p<0.05$) in pre [3.2 ± 1.0] and post [4.4 ± 0.07] intervention mean responses on question #15(N=329). Figure 4 demonstrates the changes in the prescription writing while utilizing the reference guide, critical thinking and reflection techniques. The overall D1-D4 student test scores improved dramatically with the applied techniques within a 2 hour window of application. University curriculum usually requires a student to score 75% or higher to achieve competency with prescription writing. Figure 4 demonstrates a dramatic acceleration toward the 75% goal. However, student percentages demonstrate overall failure in achieving competency for all 4 years of dental students with Post-Intervention average scores of D1-47.69%, D2-37.56%, D3-48.35%, and D4-60.70%.

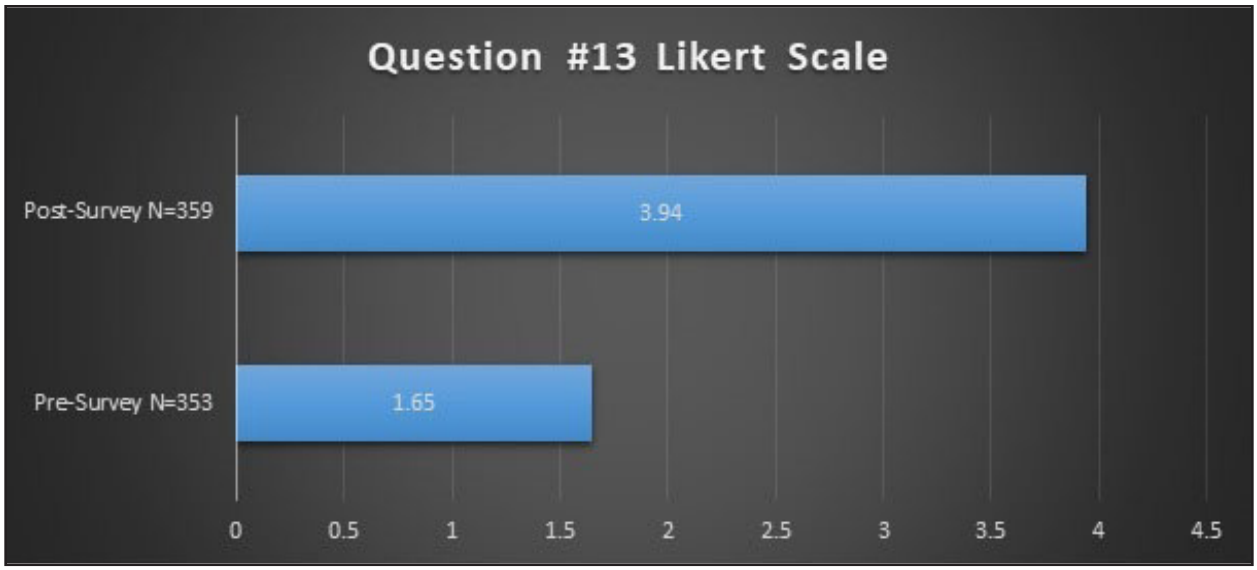

Figure 1. Question #13: The clinic reference guide to prescription writing makes it easier to understand what medications I need to prescribe for my patients in clinic.

*Critical Thinking Framework Technique- Strongly Agree/Agree Answers Combined for D1-D4 students and converted to a 5 point likert scale for comparison. A dependent within subjects t-test determined a significant difference ($p<0.05$) in pre [3.0 ± 1.1] and post [4.3 ± 0.8] intervention mean responses on question #13 (N=342).

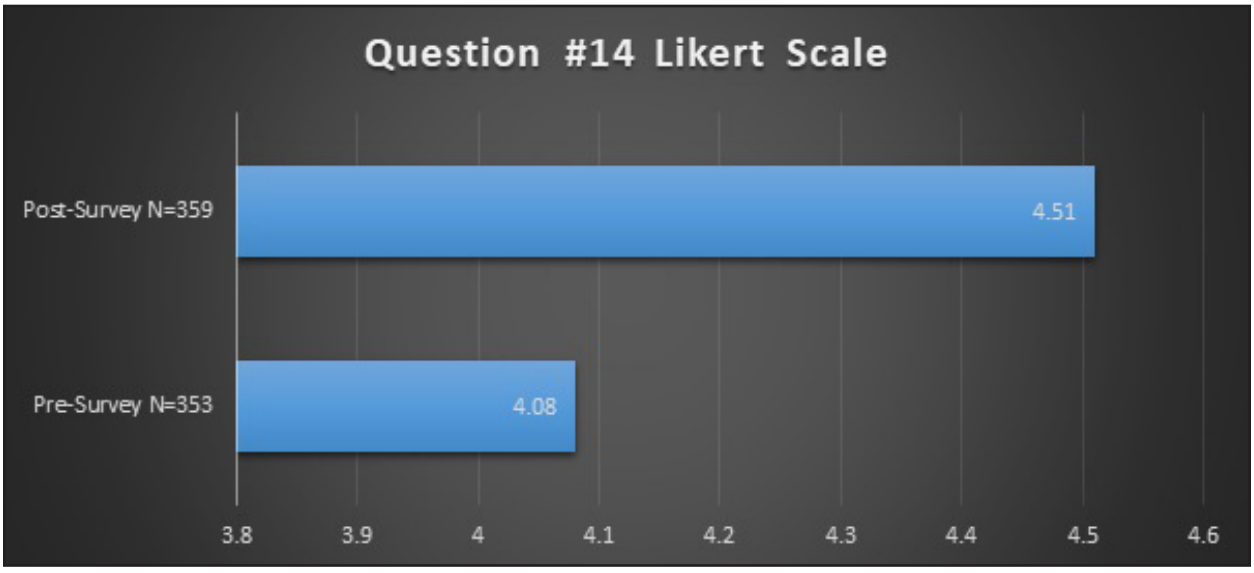

Figure 2. Question #14: Practice writing prescriptions makes me feel more comfortable with prescribing in the clinic.

*Deliberate Practice Model Technique-Strongly Agree/Agree Answers Combined for D1-D4 students and converted to a 5 point likert scale for comparison. A dependent within subjects t-test determined a significant difference ($p<0.05$) in pre [3.2 ± 1.0] and post [4.5 ± 0.7] intervention mean responses on question #14 (N=345).

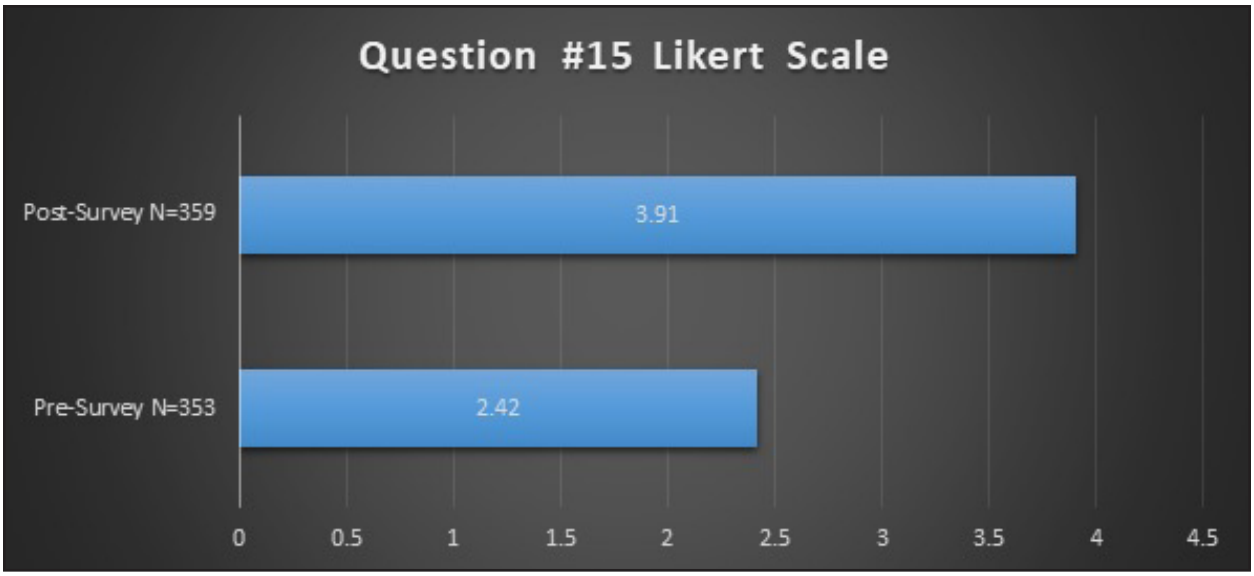

Figure 3. Question #15: The clinic reference guide makes writing prescriptions easier in clinic.

*Reflection Technique- Strongly Agree/Agree Answers Combined for D1-D4 students and converted to a 5 point likert scale for comparison. A dependent within subjects t-test determined a significant difference ($p<0.05$) in pre [3.2 ± 1.0] and post [4.4 ± 0.7] intervention mean responses on question #14 (N=329).

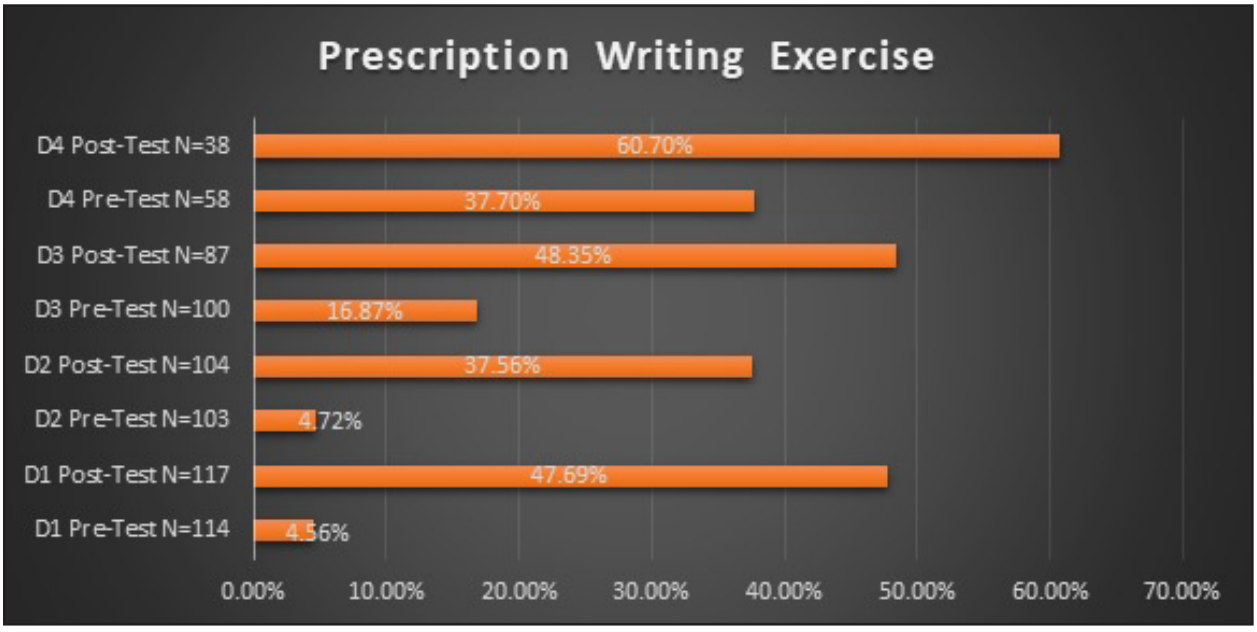

Figure 4.

*3 Prescription writing cases administered before and after the traditional lecture. Each prescription case had 5 points possible with a total of 15 points per student per prescription exam. Percentages reported of average test scores with 100% the maximum grade for each class.

Discussion

Every exercise will require a different number of learning techniques. Some smaller exercises may require one technique, whereas, large complex assignments may require 2 or more techniques. This complex assignment study yielded optimal results with 3 different learning techniques to complete the objectives for the assignment. The findings of this study show that the combination of critical thinking, deliberate practice and reflective exercises during a complex student assignment maximizes student outcomes in multiple ways. First, utilizing the critical thinking framework allowed each student on different cognitive and educative levels to explore and enhance their data collecting skills in the critical thinking framework process. Figure 1 demonstrates student mean scores drastically increased from pre-intervention responses of 3.0 to a post-intervention response of 4.3. This indicated a positive enhancement of critical thinking skills during case application. Second, deliberate practice results (see Figure 2) demonstrated a positive increase with a mean pre-intervention responses of 3.2 and post-intervention responses of 4.5. This proves repetitive deliberate practice of a task utilizing a guide helps transfer information from short term memory to long term memory. This transfer of knowledge frees up space in the short term memory and allows the student to maximize exercise outcome and positively affects performance by making certain tasks routine as seen in studies conducted by the American Psychological Association (Brabeck et al., 2019). Third, the reflective technique utilization results can be reviewed in Figure 3 (question #15). These results showed the students ability to complete the assignment and evaluate the effectiveness of the writing prescription guide while utilizing the reflective technique process. Exercise reflection showed a beneficial increase with reported mean pre-intervention responses of 3.2 and post-intervention responses of 4.4. While reflecting on the complex assignment results, students enhanced their reflective assessment and evaluation skills while improving self-efficacy in a variety of ways. When a student reflects on the complex assignment, they can assess the positive and negative outcomes, and refine their new approach to a similar situation in the future. Figure 4 demonstrates the application of all 3 techniques during prescription writing. Pre-test and post-test averages for all 4 years of dental students was reported in percentages for comparison (D1-4.56%/47.69%, D2-4.72%/37.56%, D3-16.87%/48.35%, D4- 37.70%/60.70%). The pre-test scores marked a baseline knowledge of students in different curricular levels and post-test results measured the application of the 3 techniques of critical thinking, deliberate practice and reflection in different curricular levels. By analyzing data of dental students in their respective class, this study was able to identify not only strengths and weaknesses in our students, but also in our curriculum. While showing a dramatic positive increase in post-test scores (see Figure 4) with the application of these three techniques during prescription writing, students were still unable to achieve the 75% level of competency with just one classroom application. Striking results showed the D1 class scored higher post-test results of 47.69% than the D2 class of 37.56% and the D1 class was almost equal to the D3 class of 48.35%. The D4 class

achieved the highest post-test score average of 60.70%. Recommendations to the curriculum committee to increase the number of students achieving competency would include episodes of deliberate practice while utilizing a condensed guide and exercise application to enhance critical thinking and reflective skills in all 4 years of the dental curriculum.

Limitations

This study used a sample of D1-D4 students. Several limitations were found. The first limitation we observed was a higher participation level from the D1 and D2 students, which may not be wholly representative of a 4 year dental curriculum. In the D1 and D2 year, students are exposed to pre-clinical coursework, whereas, in the D3 and D4 years the students apply their pre-clinical course knowledge in the clinical setting. Another limitation of this study was related to the timing in the spring semester. This research study fell within the last 3 weeks of the semester yielding distractors such as project deadlines, finals, graduation and boards. These distractors influenced a very low participation level of the D3 and D4 students compared with the D1 and D2 class levels. Additionally, this study did not account for any other participation of dental students from other institutions. For future investigations into complex assignment techniques, it would be beneficial to move the research date to follow midterm completion in the spring semester. Changing the timing, may yield higher participation levels of the D3 and D4 classes which would make the sample distribution more equal for a four year dental curriculum study. Including other dental schools may lead to a better understanding of techniques utilized in other dental schools and their preferred techniques and student outcomes.

Conclusion

This study answers the call of how to complete complex exercises in the classroom while utilizing an educators teaching technique choice and reference guide. All the authors identify as educators with the daily task of choosing the correct learning technique for each individual student. The authors hope to have made the case for guiding students on all cognitive and educative levels during classroom and clinical exercises. Deliberately practicing a task while applying one or more teaching techniques will contribute to the completion of any assignment while striving for maximum results.

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