Using Dental Students’ Preclinical Performance as an Indicator of Clinical Success


Abstract: The purpose of this study was to evaluate part of one dental school’s predoctoral curriculum by investigating correlations between students’ final grades in two preclinical courses and their performance in the related clinical courses. The sample consisted of 301 students at Tufts University School of Dental Medicine who graduated in 2010 and 2011. All final grades used as data were obtained from the Registrar’s Office and evaluated anonymously. The average preclinical final grades differed significantly for students in the 2010 (M=84.92, SD=3.35) and 2011 (M=79.67, SD=4.67) classes, as did their average clinical final grades (2010: M=88.38, SD=2.13; 2011: M=87.45, SD=2.06). The data for each class were therefore examined separately. Results showed that the correlation between students’ preclinical grades and clinical grades in operative dentistry and fixed prosthodontics was statistically significant (2010: r²=0.144, p<0.001; 2011: r²=0.261, p<0.001). This finding suggests there may be a positive relationship between preclinical and clinical performance of these students; however, the discrete factors contributing to that relationship were not investigated in this study and require further research.

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The assumption in dental education has always been that preclinical training is essential to the development of students’ manual dexterity and comprehension of procedures needed to succeed in the clinic. Factors that may help predict a student’s success in dental school have been researched. Of particular interest has been how cognitive exams such as the Dental Admission Test (DAT), National Board Dental Examination (NBDE) Part I, and perceptual ability and manual dexterity tests predict a student’s success in preclinical didactic courses and/or the clinic. Researchers have found DAT academic scores and grade point average (GPA) to be valid predictors of academic success in didactic courses, but these measures were poor predictors of success in preclinical courses. Additional studies found that a high score on the perceptual ability subsection of the DAT correlated with high marks in preclinical courses. Other researchers reported that predental GPA, DAT, and NBDE Part I scores were poor predictors of clinical success, while another study found students’ possession of the “conscientious” personality trait positively correlated with academic and clinical success in all four years of dental school. Given the importance of preclinical training to ensure students have the necessary knowledge and skills to enter the clinic, it is surprising that there has not been more research on the effectiveness of preclinical training on clinical success.

Two studies did measure the relationship between student performance in preclinical and clinical courses based on students’ working on a typodont and on a live patient. Curtis et al.’s study with third-year dental students examined the correlation between performing a three-unit fixed partial denture on a typodont and a patient-based competency exam. The clinical portion included full veneer preparation, fabrication of a provisional, and delivery of a full crown. These researchers found no correlation between outcomes on a typodont and on a live patient and concluded that the typodont was not an accurate indicator of students’ clinical skill and competence on a live patient. Another study examined the correlation between fourth-year dental students’ clinical performance on a typodont and on live patients. The students prepared typodont teeth for metal ceramic crowns; the same group of students then fabricated a clinical crown on a live patient. In both scenarios,
students took a final polyvinylsiloxane impression they later poured up. Faculty members evaluated the casts using calibrated grading criteria that assessed occlusal reduction, axial reduction, margins, design, and operative environment. These researchers concluded that performance on a typodont was a poor predictor of a student’s clinical performance on patients.

The purpose of our study was to determine if a correlation existed between dental students’ final grades in two preclinical courses (operative dentistry and fixed prosthodontics) and their clinical performance in the same areas. We hypothesized that the level at which the students performed in the preclinical technique courses would predict how successful they were in the clinic, using final grades as a measure of performance. We thought that students who received high final grades in preclinical technique courses would receive high final grades in clinical courses and that students who did poorly in preclinical courses would receive low grades in the clinic. This correlation would suggest that preclinical coursework is essential in the development of manual dexterity and dental knowledge needed for success in clinic. What distinguishes our study is that it tracked a group of students’ progress as they moved through the curriculum as opposed to previous studies that tested students at the end of their dental education on a typodont and a live patient. This study thus has important implications for curricular change and dental skills training.

**Methods**

This retrospective study was conducted at Tufts University School of Dental Medicine (TUSDM). All of the final grades used as data for evaluating preclinical and clinical performance were obtained from the Registrar’s Office. The data obtained were made anonymous, and all standard ethical principles pertaining to data protection were strictly followed. Only the staff assigned to the project in the Registrar’s Office had access to the key connecting randomized identification numbers to student identities. The project received approval from the Tufts University Health Sciences Campus Institutional Review Board.

**TUSDM Grading Criteria**

In the required preclinical courses, students’ practical skills are tested with exams administered throughout courses. The dates of these exams are determined and announced at the beginning of each semester. Prior to each practical exam, all faculty members are calibrated using predetermined objective criteria. To ensure fairness and impartiality, all practical examinations are graded anonymously. Grading is done in teams of two to ensure reliability, and the course director reviews any unacceptable grade. If a student’s final average in the preclinical course is a failing grade, he or she must attend remedial sessions with the course director and pass a series of competency exams. There were only seven failing grades in the entire study: four students in the class of 2011 received failing grades in operative dentistry, and one student in the class of 2010 and two in the class of 2011 did so in fixed prosthodontics. In these instances, failing grades were used for all statistical analyses.

All preclinical practical exams are performed in the simulation clinic and are divided into major categories depending on the project. Each category is graded on a three-point scale in which 1=unacceptable, 2=acceptable, and 3=ideal. The category scores are then added for a total score. In operative dentistry, there are three major categories, and an additional point is given for proper rubber dam placement, resulting in a maximum grade of 10. To calculate the numerical grade, the practical grade is multiplied by 10. In fixed prosthodontics, there are four categories giving a maximum grade of 12. Numerical grades on the twelve-point scale are as follows: 12=100, 11=94, 10=88, 9=82, 8=76, and 7=70.

Students receive a combined clinical grade for operative dentistry and fixed prosthodontics in their third and fourth years. Each clinical competency examination has an evaluation sheet specific to the project. The student’s grade is determined by the sum of each graded category. Depending on the project, some categories can be weighted more heavily than others. Grades for each category are scored as excellent (91-100 percent), acceptable (70-90 percent), or unacceptable (0-69 percent). An unacceptable in any category constitutes a failure. If a student fails a competency exam, he or she will have to do a makeup examination and will automatically receive a 70 percent for that competency. All passing grades on competency exams are final and cannot be redone for a higher grade.

In the first-year operative dentistry course, six practical exams are administered, and the best five grades are averaged to determine the final practical grade. The competency exams are as follows: #30 Class I occlusal preparation for composite restora-
tion, #19 Class II MO preparation, #9 Class IV MIFL composite restoration, #19 Class II MO amalgam restoration, #14 Class II MO amalgam restoration, and #3 Class II MO amalgam restoration. In the second-year fixed prosthodontics course, five practical exams are administered, and the best four grades are averaged to determine the final practical grade. The competency exams are as follows: #8 all-ceramic crown preparation, #13 clear template provisional crown, three-unit bridge prep of #18-20, three-unit gold bridge #18-20 provisional, and #13 PFM crown preparation.

Third-year students are required to complete six graded competencies: two operative and four fixed prosthodontics, which are weighted equally to make up the final grade. The two operative competencies are a simulated Class II amalgam restoration and Class III composite restoration performed on typodonts. The four fixed prosthodontics competencies are two facebow and mounted study casts and one maxillary and one mandibular alginate impression on live patients. Fourth-year students are required to complete thirteen competencies: seven operative and six fixed prosthodontics. The seven operative competencies are as follows: two amalgam restorations, two anterior composite restorations, two posterior composite restorations, and one mock North East Regional Board of Dental Examiners (NERB) exam restoration on any lesion. The six fixed prosthodontics competencies are as follows: two crown and bridges on a live patient, simulated #19 cast metal crown abutment preparation, simulated #21 PFM crown abutment preparation, simulated #9 full ceramic crown abutment preparation, and one wax-up examination.

In addition to these graded competency examinations, which determine a student’s clinical final grade in operative/fixed prosthodontics, students have to complete many Minimum Procedure Examinations (MPE) pass/fail competencies in order to graduate. Performance on the MPEs is not factored into the student’s numerical final grade in operative dentistry/fixed prosthodontics and was therefore not included in this analysis.

Statistical Analysis

To evaluate the relationship between preclinical courses and clinical courses, we calculated the correlation between the students’ practical grades in the same discipline. Specifically, the preclinical classes were first-year operative dentistry and second-year fixed prosthodontics; the corresponding clinical grades of interest were for operative dentistry and fixed prosthodontics, respectively.

The coefficient of determination was used to determine the relationship between preclincial and clinical final grades. Preclinical operative dentistry and fixed prosthodontics are offered as separate full-year courses. However, they are grouped together in one grade during clinical rotations in the third and fourth years. In an effort to streamline the results and ensure properly matched variables, we averaged first- and second-year practical grades to find a preclinical average. This average reflected the student’s performance in both operative dentistry and fixed prosthodontics. This value was then tested against the student’s clinical average for the third and fourth years, which also reflected the student’s performance in both operative dentistry and fixed prosthodontics.

The final practical grades in the preclinical courses were averaged to assign each student a “Preclinical Indicator Score.” This value was correlated with his or her “Clinical Outcome Score” to assess the strength of the relationship. All statistical analyses were performed using SPSS, version 19.

Results

The sample included a total of 301 predoctoral students in the graduating classes of 2010 and 2011, with 148 and 153 students enrolled in the respective classes. Descriptive statistics for the study population are summarized in Table 1. We found that there was a statistically significant difference (p<0.001) between the mean preclinical grades for the classes graduating in 2010 (mean=84.92, SD=3.35) and 2011 (mean=79.67, SD=4.67). There was also a significant difference (p<0.001) in clinic mean (SD) final grades for classes in 2010 and 2011: 88.38 (2.13) vs. 87.45 (2.06), respectively. As a result, we analyzed the correlations individually by class.

To examine the association between preclinical and clinical performance, we calculated the coefficient of determination using each student’s preclinical average grade with his or her clinical average in operative dentistry and fixed prosthodontics. Results for the 2010 class (Figure 1) showed that the correlation between preclinical scores and clinical grades was statistically significant (r²=0.144, p<0.001). For the 2011 class (Figure 2), the correlation between preclinical scores and clinical grades was also statistically significant (r²=0.261, p<0.001).
Discussion

This study examined part of the predoctoral dental curriculum by evaluating the relationship between students’ final grades in preclinical technique courses and clinical courses. What distinguished our study from previous research is that our methods allowed us to assess the learning that takes place in the preclinic. The results found a positive relationship between preclinical and clinical performance; however, the predictive effect of preclinical performance on clinical performance was weak. It is important to consider that there may be other factors that contribute to preclinical and clinical success. The discrete factors contributing to that relationship were not investigated in this study and require further research.

Both Curtis et al.’s and Nunez et al.’s studies found that preclinical training on a typodont was not an accurate predictor of clinical success on live patients. The results of our study do not challenge their conclusions since those studies used third- and fourth-year students who had successfully completed the preclinical curriculum and compared their per-
performance on fixed prosthodontics examinations on a typodont and live patient. Rather than attempting to test the accuracy and reliability of the typodont in simulating a live patient, our study attempted to assess the overall effectiveness of the preclinical dental curriculum. Mainly, we were interested in how the hands-on dental training on typodonts translates in the clinic for third- and fourth-year students. Our results suggest that preclinical training in the classroom and on the typodont was associated with performance in the clinic. However, our study did not identify the discrete factors that influence preclinical and clinical performance. Further investigation is required to analyze the effectiveness of individual aspects of preclinical education on learning dentistry.

Even though we found a statistically significant positive correlation between preclinical and clinical scores, there were a number of possible explanations as to why the magnitude of the correlation coefficient was not greater. It is important to consider that a small portion of the competencies (two of the six third-year graded competencies and four of the thirteen fourth-year graded competencies) is a simulated practical examination done on typodonts. These simulated competency exams are done as a “refresher” to help the students feel comfortable before performing the procedure on a live patient. Since the students had been tested on the same procedures on typodonts in their preclinical courses, it is possible that the repetition resulted in improved performance. This explanation would result in a narrow, positively skewed distribution of the clinic scores and a possible artificial inflation of the $r^2$ value. Although the majority of the clinic grade is performed on live patients, the inclusion of typodont scores in the clinic score may have limited the interpretive value of our correlation coefficient.

An additional reason as to why the preclinical scores were positively skewed could be attributed to the fact that the lowest practical grade in the preclinical technique classes was not factored into the final preclinical average. After reviewing the results of our study, preclinical educators might reconsider the administration of competency exams and grading criteria. For example, students who fail a single competency exam should not be allowed to drop the

Figure 2. Correlation of 2011 class’s preclinical and clinical grades
grade. In that situation, remediation for that procedure might be advisable because of implications in the clinical setting.

The ultimate goal of the preclinical dental curriculum is to prepare students to deliver the best possible care in the clinic. It is expected that students then continue to build on that foundation during their clinical education and graduate ready to enter practice. Our study suggests that the learning that takes place in the preclinic may persist in the clinic. Further research needs to be conducted to identify specific factors that influence preclinical and clinical success. For example, it would be of interest to study the effect of extra practice on preclinical performance. The extra practice could be extremely effective since psychomotor skills improve with repetition.12

Future directions for research also include reproducing the study such that the clinical grade consists solely of examinations performed on live patients. These steps would allow us to better analyze the relationship between preclinical and clinical performance. The focus of this research has important implications for increasing the percentage of students who successfully complete the preclinical curriculum on schedule as well as the on-time graduation rate. Since our hypothesis that preclinical performance is positively correlated with clinical success was supported, our findings should help to confirm dental schools’ emphasis on the importance of preclinical coursework in the training of competent dentists.

REFERENCES