Problem-Based Learning Versus a Traditional Educational Methodology: A Comparison of Preclinical and Clinical Periodontics Performance


Abstract: To evaluate efficacy of a problem-based learning (PBL) pedagogy in preclinical and clinical teaching, test scores of 234 undergraduate dental students from the conventionally taught classes of 2003 and 2004 were compared with scores of 274 dental students from the PBL classes of 2005 and 2006. Although the groups’ means were close together, t-test analysis of scores revealed that PBL students performed significantly better than traditional (TRAD) students on midterm (p=.0001) and final (p=.015) examinations taken on student partner/mock patients. ANOVA comparing the classes with each other showed significant differences for the midterm and final, but not for the clinical examination. Further multiple comparison tests (Tukey HSD) for the midterm and final revealed that differences specifically reflected superior performance of PBL classes against one of the TRAD classes (2004). There was no difference in performance between PBL (n=134) and TRAD (n=233) students on examinations taken with actual clinical patients who were undergoing nonsurgical periodontal treatment. Over a two-year period, PBL students rated their program instructors at a mean of 4.41 on a Likert-type scale of 1 (not helpful) to 5 (outstanding). The program provides a PBL model for teaching preclinical and clinical skills supported by a four-year evaluation of manual skills outcomes.

Problem-based learning (PBL) has been widely explored and tested in medical education and has gained much attention in dental education since the Institute of Medicine (IOM) report, *Dental Education at the Crossroads: Challenges and Change*, was published in 1995. The IOM report stressed exploring alternative instructional methods that would emphasize critical thinking skills, mastering principles and methods over mastering facts, integrating the basic and clinical sciences, and using computer-based and other self-paced instructional materials. Further, the report specifically named problem-based learning as possibly being the “most notable example” of such new approaches.

Beginnings of PBL pedagogy can be traced back to John Dewey’s philosophy of education published early in the twentieth century. Dewey advocated engaging the learner in everyday problems to facilitate learning. In order to foster active rather than passive learning, PBL pedagogy diverges from a conventional lecture format to emphasizing small facilitation groups in which all learning is problem-based. Emphasis is placed on inquiry and self-directed, student-centered activities.

Lloyd-Jones et al. have pointed out that PBL pedagogy can have a “coat of many colors” and is interpreted and practiced in education with a variety of strategies. A survey of sixty-four dental schools in the United States and Canada resulted in an 87 percent (n=56) response rate in which 59 percent indicated that they used some form of PBL in their curriculum. However, all but three schools (5 per-
cent) used the pedagogy for only a part of the curriculum in widely differing approaches. This lack of consistency in PBL dental education methodology has strong implications for research and evaluation. Therefore, Lloyd-Jones et al. recommended that educators should attempt to carefully document the type of PBL approach being investigated to allow greater confidence in making comparisons to traditional, lecture-based education and between PBL curricula of different schools.3

Our intent is to clearly describe a PBL preclinical/clinical periodontics program designed to teach nonsurgical periodontal skills at the University of Southern California School of Dentistry (USCSD). The central purpose of the article is to analyze outcomes of the PBL curriculum related to dental student preclinical and clinical performance in nonsurgical periodontics with emphasis on psychomotor skills. PBL examination scores were compared with those from a previously conducted traditional (TRAD) program at the same school. Results of student evaluation of the PBL periodontics program are included.

Background and Review of Literature

Since medical education has led the way for the health sciences in adoption of PBL pedagogy, dental educators who wish to adopt PBL methodology have been drawn to medical education studies that specifically address the topic of “clinical skills.” However, an examination of the medical literature reveals that the “clinical skills” spoken of in numerous articles rarely address psychomotor activity, as we know it in general dentistry.5-11 The provision of clinical dental services in general practice is dependent upon a high level of mechanical hand skills for the daily treatment of patients. As this is true to a lesser degree in the daily practice of general medicine, the feasibility of applying the findings of many medical school PBL “clinical skills” studies to dental schools may be limited.

In 1985 noted PBL author Howard Barrows, M.D., published How to Design a Problem-Based Curriculum for the Preclinical Years.12 This title promises much in the way of guidance for educators focused on preclinical teaching. While the book is an appropriate and valuable resource for its intended readership of medical educators, it has questionable value for those designing a preclinical, problem-based program in dental education. The book addresses the problem-based learning process in a generic manner and provides an abundance of helpful suggestions for working with live, standardized/simulation patients. However, the patients to whom Barrows refers are always those in need of “clinical skills” defined as “clinical reasoning” and/or “clinical problem-solving,” which in general medicine are most often related to conducting physical examinations, medical history interviews, patient counseling, and the resultant medical diagnosis.13 While these particular clinical skills are vitally important to both physicians and dentists, a major thrust in general dentistry is utilization of “clinical skills” to provide dental care and dental services that are hands-on, mechanically driven procedures to maintain, restore, and replace dental tissues.

With the initiation of PBL as the approach to teaching in many dental schools with full or partial implementation (USC,13,14 Harvard,15 Indiana,16 Canada,17,18 Australia,19,20 Ireland,21 Sweden,22 England,23 Hong Kong,24 Thailand25), questions have arisen with regard to how traditional dental laboratory teaching of procedural skills is to be accomplished with a PBL pedagogy. While PBL medical education literature has been highly valued as a guide for designing PBL basic sciences programs in dental education, there is a paucity of literature available that describes or evaluates PBL programs for teaching clinical procedural skills. Thus, it can be asked: How successful are dental educators in teaching manual skills under a PBL pedagogy? How well do dental students learn clinical hand skills with PBL, student-centered, small facilitation groups? A few investigators in the dental literature have attempted to answer these questions by describing their programs and/or providing some outcome data.

MacNeil et al.18 at the University of British Columbia have described the clinical learning environment for a hybrid-PBL curriculum (part PBL and part traditional), which involves teaching psychomotor skill acquisition earlier in the curriculum with earlier exposure to patient care. Using a model called “Clinical Clerkships,” students move through the first two years of dental school as “Junior Clerks I and II” while participating as auxiliaries with “Associate and Senior Clerks,” who are upperclassmen. Although they provide a good description of a PBL approach, which utilizes early entry to the clinic and
mentoring by peers, no outcome measures on student clinical performance were available for reporting. In a follow-up article from the same school, Walton et al.\textsuperscript{26} describe integration of psychomotor skills with the clinical clerkships and give more detail of the hierarchy of clinical skills introduced from the basic to more complex along a continuum. However, they state that the program is still in early stages and outcomes are not yet known.

Educators at the University of Adelaide provide a narrative model of the entire PBL program with a description of how clinically based situations on paper are used to introduce and build a bridge between the didactic and clinical portions of the curriculum.\textsuperscript{20} Results of student perceptions show that students like the program and have a more positive reaction to dental school than students who were taught under the traditional curriculum in previous years. Thus, student perceptions are reported, but no outcome measures of clinical skills were taken.

Our review of the dental literature did not identify any previous studies that assessed the educational effectiveness of PBL methodology by measuring clinical hand skills.

### Educational Design and Research Methods

#### Emergence of PBL at USCSD

In September 1995 the University of Southern California School of Dentistry enrolled its first class of twelve students (class of 1999) in a problem-based learning (PBL) pilot program.\textsuperscript{13} The PBL pilot track was conducted parallel to the USCSD traditional dental school curriculum track over the next six years. Outcomes of the pilot class encouraged educators to begin to move away from the parallel track, toward schoolwide, full implementation of a PBL curriculum with the entering class of 144 students (class of 2005) in September 2001.\textsuperscript{14} Complete phaseout of the traditional course and lecture format track continued in 2002 through 2004 as new classes were admitted into the PBL curriculum each fall.

A fifteen-week, preclinical periodontics rotation was conducted for the first full class of PBL D.D.S. students (class of 2005) in the summer 2002 trimester III, the third trimester of the freshman year. For TRAD, the same rotation was taught in the fall trimester IV of the sophomore year. The traditional approach is referred to as such in the context of what was followed at the USC School of Dentistry for at least ten years prior to instituting the PBL approach. (See Figure 1 for a step-by-step comparison of the two methodologies.)

The USCSD PBL periodontics program was designed within the framework described by Fincham and Shuler.\textsuperscript{27} They described PBL dental education in general and specifically addressed dental clinical education. They advocated preclinical and clinical teaching that utilizes pre-sessions and post-sessions based on predetermined program learning goals. Since 2001, when USCSD admitted the first full class of 144 students into a PBL curriculum, lectures have been omitted and all material is introduced in the form of patient case histories, which are presented in the small facilitation groups.

**Daily Goals.** A schedule of faculty predetermined goals (see Figure 2) for the trimester is provided for students at the first meeting date. In addition to the learning of instrumentation skills, other topics (Figure 3), which reflect the entirety of the conventional preclinical periodontics course objectives, are announced with the daily goals. Updates and/or changes in daily goals and exercises, as well as other information related to scheduling, laboratory/clinic policy changes, etc., are emailed to students and facilitators before each rotation meeting.

**Pre-Session and Post-Session.** During the pre-session, students discuss “mini-cases” (see example in Figure 4), which for preclinical purposes are more task-oriented and not as lengthy as cases used for standard basic sciences and didactic material covered outside of the preclinical setting. Students determine facts, ideas, learning needs, and develop and write down their personal daily objectives (Figure 4) designed to meet the stated daily goals.\textsuperscript{28} It is important to note that the students will not come up with exactly the same facts, ideas, learning needs, or personal objectives, but facilitators will guide students from week to week to cover all the topics by the end of the rotation. Since daily goals are mandatory, faculty are assured that students will address the material. Aside from daily goals, which are usually task exercises, students may determine that they have covered the material in other cases presented elsewhere and, therefore, may or may not need to review the material again at the present time. Students divide up the responsibility for learning needs reports, develop the reports from written or web-
based sources over the week, and email group members and facilitators the reports before their next meeting.

Learning needs are discussed each week in pre-session before beginning a new mini-case evaluation, and facilitators help students determine whether learning needs topics have been adequately covered or require further investigation. Pre-sessions are followed by laboratory simulation practice on manikins or clinic practice on a student partner. Students are rotated to the clinic or simulation laboratory every other week.

Each meeting closes with a post-session in which students evaluate their success in accomplishing their personally designed daily objectives. Facilitators are available as resource experts to answer

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<tbody>
<tr>
<td>8:00 am</td>
<td>PRE-SESSION</td>
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<tr>
<td></td>
<td>Facilitation groups and facilitators meet in a huddle in simulation laboratory or on the clinic floor. Facilitation groups have the same student members and facilitator throughout the 15-week ROTATION, which meets one time per week in TRIMESTER III. The rotation is coordinated by a FACULTY SUPERVISOR.</td>
</tr>
<tr>
<td></td>
<td>1. A MINI-CASE for the session is handed out by the facilitator, and from then on, the pre-session is student-directed. (The mini-cases, which include specific GOALS for the day’s session, are prepared by supervising faculty, and all groups get the same case at the same time.)</td>
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<td>2. A student volunteer reads the mini-case, plus the day’s goals, aloud to the group.</td>
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<td></td>
<td>3. As students discuss the case, a student volunteer scribe writes down FACTS of the case, IDEAS about the case, and LEARNING NEEDS related to the case. The group determines what LEARNING NEEDS (LN) must be addressed with regard to understanding the case or treating the patient. The group determines a method for assigning LN reports to group members.</td>
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<td>4. Additional LNs may relate to specific goals for the day. Students determine their own personal objectives for meeting the daily goals and record their objectives on the Daily Evaluation form.</td>
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<td>5. All information recorded by the scribe is emailed to the group and the facilitator later in the day, so everyone has a copy of group proceedings and assignments.</td>
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<tr>
<td></td>
<td>6. All LN reports are prepared during the week following the session and are emailed to all group members and the facilitator before the next meeting.</td>
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<td>7. LN reports assigned to the group are reviewed at the beginning of the next session before the new mini-case is considered. Questions may be asked or a quiz may be administered by facilitators to help students assess their level of understanding on the LN topics. No grade is recorded; quizzes are for student feedback only.</td>
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<td></td>
<td>8. No lectures are given. There are no required textbooks or required reading assignments. In critique of LNs, facilitators advise students concerning appropriate resource material, the need for further investigation of LNs, and recommend specific textbooks.</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Traditional Activities: D.D.S. classes of 2003, 2004</th>
</tr>
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<tbody>
<tr>
<td>9:00 am</td>
<td>LECTURE (NO PRE-SESSION)</td>
</tr>
<tr>
<td></td>
<td>The 15-week COURSE meets one time per week for 15 weeks in TRIMESTER IV. The course is coordinated by a COURSE DIRECTOR.</td>
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<tr>
<td></td>
<td>1. All instructors and students meet in lecture hall for a 30-60 minute lecture covering instructions for the day’s activities and related information, e.g., rationale for scaling and root planing, instrument design and techniques, instrument sharpening, nonsurgical periodontal treatment planning, etc.</td>
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<td>2. Videos are shown in the lecture hall. Some are available in the dental school library as well.</td>
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<td></td>
<td>3. The next week’s reading assignment in a required textbook is announced.</td>
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<td></td>
<td>4. Each session begins with a quiz over last week’s reading assignment. Weekly quizzes comprise 20 percent of the final course grade.</td>
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Figure 1. A step-by-step comparison of two different approaches to teaching undergraduate preclinical periodontics at USCSD

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questions, provide requested demonstrations, complete student evaluations, and give feedback on technique/hand skills.

**Similarities and Differences in Methodologies.**
The USCSD PBL preclinical periodontics program retains some of the former TRAD methodology and evaluation. However, we believe that the current PBL

<table>
<thead>
<tr>
<th>9:00 am</th>
<th>PRACTICE ON TYPODONTS OR ON STUDENT PARTNERS</th>
<th>Between 9:30 am and 10:00 am</th>
<th>PRACTICE ON TYPODONTS OR ON STUDENT PARTNERS</th>
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<tr>
<td></td>
<td>Students remain in the same groups with the same facilitators. Each session is spent <em>either</em> in the simulation lab or on the clinic floor.</td>
<td></td>
<td>With small groups of one instructor and six to eight students, who are assigned to be together throughout the 15-week course, each session includes time for practice in <em>both</em> the simulation lab and on the clinic floor.</td>
</tr>
<tr>
<td>1.</td>
<td>Instructor/facilitator acts as resource expert to observe, critique, and evaluate task performance and provides verbal and/or written feedback with emphasis on the group.</td>
<td></td>
<td>1. Instructors observe, critique, and evaluate task performance and provide verbal and/or written feedback with emphasis on individual students.</td>
</tr>
<tr>
<td>2.</td>
<td>Demonstrations by instructors in lab or clinic sessions are provided as requested by students. Videos are shown in sim lab or are recommended for library viewing, as most are available in the library.</td>
<td></td>
<td>2. Demonstrations by instructors in lab or clinic sessions are provided as scheduled.</td>
</tr>
<tr>
<td>3.</td>
<td>Students practice instrumentation as determined by the announced daily goals and the personal objectives they described in pre-session.</td>
<td></td>
<td>3. Students practice instrumentation in the area of the mouth as scheduled, but may practice other areas with instructor permission.</td>
</tr>
<tr>
<td>4.</td>
<td>Other activities, e.g., topical fluoride application, subgingival irrigation, coronal polishing, are performed as announced in the daily goals and in compliance with student written objectives.</td>
<td></td>
<td>4. Other activities, e.g., topical fluoride application, subgingival irrigation, coronal polishing, are performed as scheduled.</td>
</tr>
<tr>
<td>5.</td>
<td>Evaluation forms for tasks and procedures may be used as feedback, but are not recorded as part of the final course grade.</td>
<td></td>
<td>5. Evaluation forms for tasks and procedures may be used as feedback, but are not recorded as part of the final course grade. Daily work, attendance, attitude, and participation are jointly counted as 30 percent of the final grade.</td>
</tr>
<tr>
<td>6.</td>
<td>Students are given a midterm and final OSCE administered on a mock patient/student partner. (Formerly called “midterm and final exams” in the traditional methodology, otherwise the same.) Grades are turned in to Academic Affairs to apply to DPBL 504 Dental Problem-Based Learning, Human Clinical Dentistry I.</td>
<td></td>
<td>6. Students are given a midterm and final examination administered on a student partner/mock patient. Each exam counts 25 percent toward the final course grade.</td>
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**POST-SESSION**

Post-sessions generally last from 15 to 30 minutes, but could last as long as 60 minutes, depending on the needs of the students.

1. Personal learning objectives written on the Daily Evaluation form are assessed by students with instructor facilitation to determine whether or not they have been achieved.
2. Questions that might be asked by students of themselves: What have we accomplished? What have we learned? Do I understand? Do I need to learn more? Have new LNs surfaced? What was encountered that was not anticipated? What help was needed on the clinic floor/in the lab? What type of assistance was needed from faculty? What problems arose and how could a classmate be advised to handle similar problems?
3. Daily Evaluation forms are quite open-ended with broad categories. The forms provide opportunity for formal self-evaluation and instructor evaluation. Forms are turned in to Academic Affairs to apply to DPBL 504 Dental Problem-Based Learning, Human Clinical Dentistry I to average with grades submitted from other clinical areas.

<table>
<thead>
<tr>
<th>12:00 noon</th>
<th>SESSION CONCLUDES</th>
<th>12:00 noon</th>
<th>SESSION CONCLUDES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 11:00 am and 11:45 am</td>
<td></td>
<td></td>
<td><strong>NO POST-SESSION</strong></td>
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Note: Students generally worked in both the lab and the clinic each session in the traditional program, with a greater amount of time spent in the clinic.
preclinical periodontics pedagogy differs significantly from what was formerly followed at USCSD. The literature is replete with articles describing the various modes of PBL being followed in medical and dental schools. Camp has discussed the range from “pure” to “impure” variations and noted the difficulty in analyzing and comparing outcomes from programs that differ greatly in the educational delivery of PBL. Camp states that PBL is not pure when it is not student-centered, when much instruction is still in traditional formats such as lectures and highly structured labs, or when it involves only one or a few PBL-conducted courses existing alongside of the traditional courses. Key words describing PBL are “active, adult-oriented, problem-centered, student-centered, collaborative, integrated, interdisciplinary, utilizes small groups and operates in a clinical context.”

The program at USCSD is “pure” in the sense that it utilizes all the concepts described by Camp as “pure” and no longer emphasizes any of the concepts she describes as “traditional” or “not pure.” As advocated by previous investigators, we have attempted to give a detailed description of both our PBL and TRAD preclinical periodontics programs so that our PBL program can be accurately evaluated, criticized, and, if desired, replicated by others.

<table>
<thead>
<tr>
<th>Week</th>
<th>Goals</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Take and record vital signs, medical history, and intra- and extraoral exam using axium computer software (on student partner).</td>
</tr>
<tr>
<td>2</td>
<td>Probe mandibular arch in sim lab on typodont.</td>
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<tr>
<td>3</td>
<td>Probe and perio chart mandibular arch on student partner.</td>
</tr>
<tr>
<td>4</td>
<td>Probe maxillary arch in sim lab on typodont.</td>
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<tr>
<td>5</td>
<td>Probe and perio chart maxillary arch on student partner.</td>
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<tr>
<td>6</td>
<td>Explore maxillary and mandibular arches in sim lab on typodont; provide toothbrushing instruction for student partner.</td>
</tr>
<tr>
<td>7</td>
<td>Explore maxillary and mandibular arches on a student partner; flossing instruction.</td>
</tr>
<tr>
<td>8</td>
<td>OSCE midterm; Probe &amp; Explorer Performance Evaluation.</td>
</tr>
<tr>
<td>9</td>
<td>Practice Gracey curettes (sickles and universals) on anterior sextants in sim lab on a typodont.</td>
</tr>
<tr>
<td>10</td>
<td>Practice Gracey curettes and others on anterior sextants on a student partner; subgingival irrigation with betadine.</td>
</tr>
<tr>
<td>11</td>
<td>Practice Gracey curettes on mandibular posterior sextants in sim lab on a typodont; instrument sharpening exercise.</td>
</tr>
<tr>
<td>12</td>
<td>Practice Gracey curettes on mandibular posterior sextants on a student partner; coronal polishing; topical fluoride application.</td>
</tr>
<tr>
<td>13</td>
<td>Practice Gracey curettes on maxillary posterior sextants in sim lab on typodont.</td>
</tr>
<tr>
<td>14</td>
<td>Practice Gracey curettes on maxillary posterior sextants on a student partner; evaluation of universals and sickles.</td>
</tr>
<tr>
<td>15</td>
<td>OSCE final; Gracey Curette Instrumentation Performance Evaluation.</td>
</tr>
</tbody>
</table>

Figure 2. Daily goals by session
Measurement for the Study

Available scores from two preclinical examinations administered on student partner/mock patients and one clinical competency examination administered on a clinic patient for four classes over a four-year period were used for statistical analysis in comparing PBL to TRAD performance. At the time of data analysis, the PBL class of 2006 had not yet completed the clinical competency examination; therefore, that class is not included in this part of the analysis. This educational research was approved by the USC Institutional Review Board, UPIRB #02-10-161.

Daily Evaluations. Daily evaluation grades are not included in the measurement of this study because the form, which has multiple purposes, was unsuitable for our specific focus of educational research evaluation of psychomotor skills. The form monitors daily attendance, guides activities related to goals and objectives, and provides a record of student self-evaluation and instructor feedback comments. The daily grades are computed by the Office of Academic Affairs, averaged in with grades that are given in other preclinical disciplines, and recorded as part of a course grade for DPBL 504 Dental Problem-Based Learning, Human Clinical Dentistry I.

Although other topics are covered in the daily goals, only the topics directly related to the measurement and evaluation of the preclinical and clinical skills of probing, exploring, scaling, and root planing are evaluated in this study.

Preclinical Measurement. The preclinical rotation includes what is referred to here as a “preclinical” examination taken on a student partner who acts as a mock patient. Strictly speaking, the examination is not preclinical in the sense that it involves only simulation/manikin use, but it is preclinical in the sense that the mock patient is only being engaged for “practice” of the skills and is not a “real” clinic patient undergoing periodontal treatment.

PBL students were given objective structured clinical examinations (OSCEs) twice during the trimester. In 1975 the OSCE examination was introduced to medical education by Harden and Gleeson,29 who suggested testing clinical competency using timed, procedural, or question stations. The OSCE has been modified in medical and dental education to reflect a variety of different formats.30-36 O’Neill defined the OSCE in this way: “The OSCE is an ex-

PERI 550a Course Objectives:

- Obtain and record a medical health history, including vital signs.
- State the rationale and importance of physical evaluation of the patient before treatment.
- Perform an intraoral and extraoral examination and chart findings.
- Demonstrate accurate dental and periodontal charting.
- Accurately identify, describe, and classify the periodontal condition of a student partner.
- Describe instrument design and classification.
- Accurately determine, select, and use the proper armamentarium for initial preparation therapy in periodontics.
- Demonstrate process instrumentation with guidance from instructors on both a typodont and a student partner.
- Demonstrate the ability to integrate the principles of grasp, fulcrum, blade adaptation, instrument angulation, patient and operator positioning, and apply the principles to each sextant of the mouth.
- Demonstrate, at a basic proficiency level, instrumentation with the periodontal probe, 3A explorer, Nabers probe, Gracey curettes, universal and sickle scalers, utilizing correct operator positioning.
- Discuss the basic principles of scaling and root planing.
- Discuss the rationale for, and demonstrate the proper technique of, scaling and root planing.
- Describe nonsurgical periodontal treatment planning for different types of cases, including pain management.
- Provide oral hygiene instructions appropriately planned for the needs of each patient.
- Discuss the indications for, and demonstrate proper technique of, coronal polishing.
- Discuss indications for, and demonstrate proper technique of, topical fluoride application.
- Discuss indications for, and demonstrate proper technique of, subgingival irrigation.
- Define “periodontal abscess,” and discuss nonsurgical treatment approaches for the condition.

Figure 3. Course objectives for the traditional course, PERI 550a, Introduction to Clinical Periodontics. All content is covered in the new PBL preclinical periodontics rotation.
amination in which the students are evaluated by being asked to perform a specific, well-defined task that is clinical in nature using either a standardized or mock patient.37

Examinations of this type, which use mock patients, may or may not be called OSCEs, but have been widely used in medicine and in dentistry by both traditional and PBL educators.38-40 At USCSD, a midterm examination OSCE (Periodontal Probe and Explorer Performance Evaluation) and a final examination OSCE (Gracey Curette Instrumentation Performance Evaluation) are administered on a dental student clinic partner, who acts as the mock patient.

The OSCEs used for evaluation in the USCSD PBL program are of same format and are recorded on the same forms previously administered as midterm and final examinations in the TRAD curriculum. Therefore, this particular evaluation mode has

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**Mini-case**

**Patient: Jacqueline Doe**

Jacqueline Doe arrives for continuation of her periodontal therapy with you. She has been scheduled for scaling and root-planing by sextants with anesthesia.

Before you begin, she asks, “What is subgingival irrigation? Do I need that?”

**Learning goals**

Simulation laboratory:
1) Perform periodontal instrumentation for anterior sextants on a typodont (Gracey 5/6, including mini-bladed 5/6, universal, sickle)
2) Next week in clinic: Provide subgingival irrigation with betadine solution in one quadrant on a partner

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From the mini-case and the goals, in small facilitation groups students determine (possible scenario of student interpretation follows):

**Facts**

J. Doe has arrived and we will continue with her periodontal therapy today. Today she is scheduled for scaling and for root-planing (sc/rp). One sixth (one anterior sextant) will be sc/rp today. Local anesthesia will be used in the area. J. Doe has requested information about subgingival irrigation. J. Doe wants to know the rationale for subgingival irrigation.

**Ideas**

1) Local anesthesia is required for sextant scaling because subgingival scaling can cause pain, discomfort, and tissue trauma.
2) Certain types of injections are appropriate for obtaining anesthesia in the anterior sextants of the mouth.
3) Scaling and root-planing (sc/rp) of anterior teeth requires different instruments than the posterior areas.
4) Sc/rp of the anterior teeth requires particular techniques, fulcrums, and operator/patient positioning.
5) A patient’s teeth need to be scaled and root planed in sextants when periodontal probing pockets are deep and the calculus is heavy and hard to remove (tenacious), which will require more time than a regular scaling appointment. (Scaling is something different from root-planing.)
6) Subgingival irrigation is required when the gingiva is extremely inflamed, and it is effective in reducing the inflammation.

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**Figure 4. Example of a mini-case, learning goals, facts, ideas, learning needs, and personal objectives**
been held in common by both the TRAD and PBL preclinical periodontics programs at USCSD. It should be noted that the D.D.S. periodontics examinations used are patterned after those developed by the USC dental hygiene program, which emphasize clinical skills graded in such criteria and categories as operator positioning, patient positioning, instrument selection, grasp, demonstration of standard and alternative fulcrums, demonstration of working versus exploratory strokes, proper adaptation to the tooth, insertion of instrument into the gingival sulcus, etc. The midterm and final consist of 60 and 124 points respectively with 70 percent achievement required for a passing score.

Clinical Measurement. With both the TRAD and PBL approaches, a seven-week session in which students see their first clinical patients for scaling and root planing follows the initial fifteen-week preclinical rotation. The difference in sequencing is that the PBL students enter the clinic one trimester earlier than TRAD students entered. For the clinical rotation, four scaling sessions are required as a minimum. One session must be a clinical examination (Periodontics Performance Evaluation: 100 points, 70 percent passing) administered on a periodontally involved patient, who exhibits moderate to heavy subgingival calculus. The clinical examination and form used have been exactly the same for both the TRAD and PBL students.

Faculty. Facilitators meet for in-service, clinic, and exam calibration three to five times per trimester and receive weekly instructor calibration guides.

7) Subgingival irrigation services in the dental office can be performed by different providers.
8) Different techniques of application and different antimicrobial solutions can be used for subgingival irrigation.

Learning needs (each is linked to an idea as numbered):
1) Rationale for use of local anesthesia and pain management for scaling and root-planing.
2) Types of injections used for anterior anesthesia: oral landmarks for injection site, innervation of anterior areas, armamentaria for local anesthesia, types of solutions, and anesthesia technique.
3) Different types of instruments used for anterior scaling and root-planing and advantages and disadvantages of each.
4) Techniques for accessing subgingival surfaces and sc/rp of anterior teeth: fulcrums, patient/operator positioning and so on.
5) Nonsurgical periodontics treatment planning (number of appointments needed for different types of cases) based on need for scaling, root-planing, or both (def. of scaling vs. root-planing) and amount of deposit present.
6) Rationale for subgingival irrigation and the evidence-base for its effectiveness.
7) Subgingival irrigation, professional vs. self-care, and providers who can legally perform the service in California as per the dental practice act.
8) Techniques for providing subgingival irrigation, different types of antimicrobials available, products available for home use, and patient education with regard to subgingival irrigation.

Personal learning objectives for today based on mini-case and goals.
Observe my instructor perform upper and lower anterior sc/rp on typodont (request demonstration from instructor).
Practice scaling typodont with anterior Gracey curette, universal, and sickle following my lab manual.
Learn patient/operator positioning, instruments, grasp, and fulcrums for sc/rp anterior sextants.
by email and a daily session folder with the needed paperwork for their group.

The number of faculty needed to maintain a 6:1 student faculty ratio varied from thirteen to thirty per trimester over the four years. Most instructors were dental hygiene graduates ranging from recent graduates to those with advanced degrees at the master’s or doctorate level (Ph.D. or D.D.S.). The remaining instructors (3-15 percent) held a D.D.S. degree or were periodontists as well. Recent dental hygiene graduates, who comprised from 23 to 33 percent of the faculty, were well versed in instrumentation technique and were familiar with the examination format. In the two PBL classes, four to six D.D.S. PBL students held dental hygiene bachelor’s degrees and participated as facilitators rather than as students, but did not administer any examinations to classmates. Several of the PBL D.D.S./D.H. graduates had prior periodontics D.D.S. teaching experience as they had worked as part-time periodontics faculty between their dental hygiene graduation and their enrollment in dental school.

**Statistical Analysis**

This investigation used scores from the midterm and final OSCEs (PBL) and the midterm and final periodontics performance examination scores (TRAD) for classes of 2003 (TRAD), 2004 (TRAD), 2005 (PBL), and 2006 (PBL). Clinical examination scores with actual clinic patients were available only for the classes of 2003 (TRAD), 2004 (TRAD), and 2005 (PBL). An independent sample t-test addressed possible gender-related differences in performance. Additionally, a summary of preclinical rotation ratings (Likert-type scale) filled out by students from PBL classes of 2004 and 2005 is included.

Scores for the Advanced Student Program for International Dentists (ASPID, Class of 2005), which enrolls graduates of foreign dental schools, were not included in this evaluation. They were omitted as no scores from traditionally (TRAD) taught ASPID classes were available for comparison to PBL.

Scores were analyzed with use of SPSS statistical analysis software with Multivariate Analysis (Multiple Regression Analysis). SPSS software was used to calculate the independent sample t-test, ANOVA, and Tukey HSD for multiple comparisons.

**Results**

The test for equality of variance was used to determine homogeneity of variance between the two groups on the primary variables of interest (scores on midterm, final, and clinical exams). The test indicated that the dental classes, considered as two different groups of students (PBL and TRAD), came from populations with equal variances.

Using the equal variance t-test for independent samples, we determined that the differences in means for the midterm (p=0.001) and the final (p=0.015) were statistically significant. The PBL group showed superior performance on both OSCE examinations (Tables 1 and 2). There was no statistical difference between group means on the clinical examination.

A linear multiple regression was conducted to evaluate the predictive value of scores on the midterm and final examinations for performance on the clinical examination. While the scores on the midterm and final were shown to be significant, F=82.90, p<0.001, the actual percent of the variance in the score on the clinical examination explained by the combination of midterm and final examination was minimal (adjusted R² = 0.132).
ANOVA and Tukey HSD post hoc multiple comparisons tests were used to determine differences in examination means between classes. ANOVA revealed omnibus F for both midterm and final, indicating a significant difference among the groups in performance (Table 3). Tukey HSD post hoc comparisons, conducted to determine which groups had different means, revealed that the class of 2004 (TRAD) performed significantly lower than any of the other classes on the midterm and lower only than the class of 2005 (PBL) on the final. Additionally, the Tukey HSD tests for homogeneous subsets were computed to determine whether group means appeared in the same subsets (Table 4). The tests supported that the midterm mean for the class of 2004 (TRAD) was in a different subset than that of all other classes and the final mean differed in subset only with the PBL class of 2005.

An independent sample t-test was conducted to test the significance of mean differences between male and female students across all groups. No significant differences were found on the midterm, final, or clinical examinations (midterm p=.770, final p=.685, clinical exam p=.215).

Evaluation of the PBL preclinical periodontics rotation instructors by the PBL classes of 2004 and 2005 indicate an overall rating of 4.41 on a Likert-type scale of 1 (not helpful) to 5 (outstanding) (see Table 5).

**Discussion**

Combining two classes of PBL and two classes of TRAD students in an independent samples analysis showed that PBL students performed better than TRAD students on midterm OSCE and final OSCE examinations. Although statistically significant, means of the preclinical examinations are very close together, raising a question of the educational significance of the differences. A closer look at data with multivariate analysis reveals that differences in performance could be narrowed down to one of the TRAD classes (Class of 2004), which exhibited a weaker performance than any of the other classes, including the Class of 2003 (TRAD).

Although the means were close, the range of grades was wide for each class. A score of 70 percent was passing, and scores ranged from 64 percent to 100 percent with an average of one to three failures each time the exams were given. Students who fail are allowed to take review sessions and retake the examination with the rotation supervisor only. Scores used for the analysis here were the make-up grades (determined by averaging with the failing grade) of the failing students as this grade best reflects the abilities of the students at the close of the

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**Table 3. Analysis of variance for midterm, final, and clinical exams**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score on Midterm Exam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>1649.54</td>
<td>3</td>
<td>549.85</td>
<td>16.40</td>
<td>&lt;.0001</td>
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<tr>
<td>Within</td>
<td>16901.57</td>
<td>504</td>
<td>33.54</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>18551.11</td>
<td>507</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score on Final</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>205.32</td>
<td>3</td>
<td>68.44</td>
<td>2.62</td>
<td>.050</td>
</tr>
<tr>
<td>Within</td>
<td>13152.80</td>
<td>504</td>
<td>26.10</td>
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<td></td>
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<tr>
<td>Total</td>
<td>13358.12</td>
<td>507</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score on Clinical Exam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>1.59</td>
<td>3</td>
<td>.53</td>
<td>.01</td>
<td>.999</td>
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<tr>
<td>Within</td>
<td>19791.68</td>
<td>363</td>
<td>54.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19793.27</td>
<td>366</td>
<td></td>
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<td></td>
</tr>
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</table>

**Table 4. Tukey HSD test for homogenous subsets for preclinical outcomes***

<table>
<thead>
<tr>
<th>Class (N)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm</td>
<td></td>
</tr>
<tr>
<td>2004 (110)</td>
<td>86.44</td>
</tr>
<tr>
<td>2003 (124)</td>
<td>89.77</td>
</tr>
<tr>
<td>2006 (136)</td>
<td>89.95</td>
</tr>
<tr>
<td>2005 (138)</td>
<td>91.57</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Final Exam</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Class (N)</td>
<td>Mean</td>
</tr>
<tr>
<td>2004 (110)</td>
<td>90.25</td>
</tr>
<tr>
<td>2003 (124)</td>
<td>90.92</td>
</tr>
<tr>
<td>2006 (136)</td>
<td>91.40</td>
</tr>
<tr>
<td>2005 (138)</td>
<td>92.01</td>
</tr>
</tbody>
</table>

*Vertical lines connect means not significantly different at the .05 level.
trimester. Additionally, the degrees of freedom (reflecting numbers of students) included in the statistical t-test evaluation with the classes combined to represent two methodological groups only was robust, helping to support an educationally significant finding. In this research evaluation, performance differences measured between the various classes by the multivariate analysis may not be as important as performance differences between two groups taught under two different methodologies (t-test).

Similar examinations to those used with PBL have been used at USCSD for at least ten years prior to the investigation time and many more years, in a similar format, for the dental hygiene program. From a practical standpoint, the exams have served the faculty and students well for more than a decade in helping to identify students who have manual skills difficulty, need additional help, or are not ready to treat clinic patients until remedial work is accomplished. David Chambers has stated that preclinical dental education has traditionally served the purpose of imparting mastery of fundamental skills and of screening out students who lack them. The examinations at USCSD have a record of having accomplished these functions.

In the best educational scheme, it would be highly desirable and reassuring to know that what is done in the laboratory directly influences what is done in the clinic. Dental educators would like to feel confident that efforts spent teaching skills in the laboratory result in a ready transfer of those skills to the clinic. The inability of the preclinical scores to predict clinical scores is perplexing, especially since the average scores of both the preclinical and clinical tests were indicative of acceptable levels of performance.

Chambers has also addressed the problems of transferring skills from the laboratory to the clinical setting. With reference to contemporary psychology, he characterizes two ways of learning: 1) learn-
ing from performance and 2) learning from problem-solving. Learning from performance has been the common approach in traditional, preclinical dental education as students are asked to “perform” laboratory procedures and given many specific “requirements” to fulfill. An assumption has been that if tasks are repeated enough times, students will develop proficiency; this can and does often happen. It is the “practice makes perfect” adage being realized. Chambers states that the drawback of this traditional approach to performance teaching and learning is that it is generally context-specific. That is, students may become comfortable with the lab procedures, but transfer of the skills to a different setting (the clinic) is not adequately facilitated. Chambers concludes that this is why correlations of preclinical work and clinical work are often weak. In this periodontics program, PBL methodology combined the elements of learning from performance with learning from problem-solving and was still unable to linearly predict clinical performance. Ultimately, patient clinical performance averages were acceptable, even though not predicted purely on prior preclinical examination performance.

Finally, an evaluation survey administered by the Office of Academic Affairs to the PBL classes indicated a solidly positive response to the PBL methodology with overall ratings of rotation instructors averaging 4.41 for each of the two years (see Table 4). Notably, students seem to highly value use of technology such as email and other resources used in the PBL preclinical curriculum. The only student evaluation available for comparison from a traditional class was for the D.D.S. class of 2002, who rated the course director for that year at 3.97 and the course overall at 4.04 on a similar 5-point scale. The archival rating gives some indication of the traditional students’ opinion of the conventional approach, although the respondents were not part of the groups studied.

Conclusions

Preclinical and clinical dental educators have raised concerns about how to apply PBL methodology in the teaching of dental hand skills technique. This study has addressed program description and assessment of PBL pedagogy at the procedural level of teaching periodontics hand skills. More studies with similar design and detailed description of particular approaches could lead to better program evaluation across schools, as well as greater consistency and efficacy in application of PBL methodology. Further exploration with PBL as an alternative approach to traditional dental education may result in a dental curriculum that encourages clinical skills of critical thinking and decision making along with acquisition of hand skills through learning that is self-directed and group-facilitated.

In a preclinical and clinical program, four-year measurement of mock patient examinations and follow-up clinic patient examinations have shown that using a PBL methodology resulted in student performance of nonsurgical periodontics skills at a level equal to or greater than that of a conventional approach.

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REFERENCES