An Overview of Case-Based and Problem-Based Learning Methodologies for Dental Education


Abstract: Dental education has undergone significant curriculum reform in response to the 1995 Institute of Medicine report Dental Education at the Crossroads and the series of white papers from the American Dental Education Association Commission on Change and Innovation in Dental Education (ADEA CCI) first published in the Journal of Dental Education and subsequently collected in a volume titled Beyond the Crossroads: Change and Innovation in Dental Education. An important element of this reform has been the introduction into academic dentistry of active learning strategies such as problem-based and case-based learning. As an aide to broadening understanding of these approaches in order to support their expansion in dental education, this article reviews the major characteristics of each approach, situates each in adult learning theory, and discusses the advantages of case-based learning in the development of a multidisciplinary, integrated predoctoral dental curriculum.

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The landmark study Dental Education in the United States and Canada,1 sponsored by the Carnegie Foundation for the Advancement of Teaching and published in 1926, identified weaknesses of dental education at the time. The author, William Gies, reported that in the early twentieth century, dental education programs were not routinely housed in a university, did not emphasize teaching or research, and lacked the strong biological science foundation found in medicine. After the publication of the Gies report, there were important changes in dental education, such as the growth of formal affiliations with universities, the development of stronger scholarship in biomedical and clinical sciences, and the implementation of standardized accreditation processes. However, despite the sound recommendations of the Gies report and the numerous advancements in the science and technology of dentistry and innovations in education since 1926, little changed in the curriculum and structure of dental education until the 1990s.2

The Institute of Medicine (IOM) issued a new call for change in 1995. Recommendations from its comprehensive review, Dental Education at the Crossroads: Challenges and Change,3 were far-reaching and included a call for greater integration of basic and clinical sciences; the modernization of course content, structure, and delivery; and elimination of redundancy in the dental curriculum. The IOM report triggered much discussion among dental educators and other interested parties. To reinvigorate the reform agenda, the American Dental Education Association Commission on Change and Innovation in Dental Education (ADEA CCI) was created in 2005, and from 2005 to 2009 the Journal of Dental Education published a series of white papers from the ADEA CCI. In 2009, ADEA collected the series in a volume entitled Beyond the Crossroads: Change and Innovation in Dental Education.4 Intended as a follow-up to the IOM report, these white papers presented a roadmap for the future of dental education. Critical elements included a renewed focus on teaching and learning, assessment and progress toward competence, and leadership in academic dentistry.

Major efforts at curriculum reform in dental education continue, but there is yet no clear path. The purpose of this article is to provide an overview of two major teaching paradigms currently in use in
dental education: case-based learning (CBL) and problem-based learning (PBL) and to situate each in adult learning theory. As an aide to broadening understanding of these approaches in order to support their expansion in dental education, the article also aims to draw distinctions between CBL and PBL and to argue for increased use of multidisciplinary teaching in dentistry. We recommend CBL when implementing curriculum reform incorporating an active learning methodology.

Adult Learning

Given that most students entering dental school have an undergraduate degree, an exploration of CBL and PBL should include a discussion of the unique learning process experienced by adults. Knowles introduced the term “andragogy” in 1984 to distinguish differences in the learning process of adults and children, the latter more commonly known as “pedagogy.” In his theory of adult learning, Knowles proposes that adult learners “are independent and self-directing; have (various degrees) of experience; integrate learning to the demand of their everyday life; are more interested in immediate problem-centered approaches; and are motivated more by internal than external drives” (p. 11). Others have identified hallmarks of adult learning as the use of real-world, authentic problems to guide small-group discussions and have suggested that use of adult learning techniques may aid in retention of and interest in the subject matter. Contributing to this discussion is a move by many professional programs toward an approach that emphasizes learning (what the student does) over teaching (what the faculty member does), a position that supports greater use of CBL, PBL, project-based learning, inquiry-based learning, action learning, and other active learning methodologies.

The effort to adopt tenets of adult learning in dental education is also based on criticism of the traditional delivery style that presents basic and clinical sciences information primarily in a lecture format. Major and Palmer described the lecture as the most expeditious way to deliver large amounts of information to students who have become accustomed to an almost entirely passive role in learning. They write, “Students, not knowing how to be active participants in the lecture, have relied on transcription, memorization, and repetition for learning” (p. 1). Finucane et al. note that the traditional curriculum approach does not support the integration of basic and clinical sciences and can make application of acquired knowledge difficult. “The acquisition and retention of information that has no apparent relevance,” they write, “can be boring and even demoralizing for students” (p. 445). The inadequacies of the traditional pedagogic approach, the application of key elements from adult learning theory, and the recent strong calls for change reiterate the need for continuing curriculum reform in dental education.

Problem-Based Learning and Case-Based Learning

PBL gained popularity in North America in 1969, when McMaster University fully converted its medical curriculum to a PBL model. The first U.S. medical school to adopt it was the University of New Mexico in 1979, and many other U.S. medical schools, including Harvard, followed. By the mid-1990s, PBL was well established in schools of medicine around the world and endorsed by the World Federation of Medical Education and the World Health Organization.

Donner and Bickley described PBL as “a form of education in which information is mastered in the same context in which it will be used. . . . [In health professions education], PBL is seen as a student-driven process in which the student sets the pace, and the role of the teacher becomes one of guide, facilitator, and resource” (p. 294). They identified key elements of PBL as review of the problem, small-group tutorial session with students and a faculty facilitator, student-directed learning as students identify and rank issues that will be researched and reviewed in a future session, tutorial learning with students and faculty, and reciprocal student-faculty evaluations. Others have emphasized that PBL is constructive, collaborative, and contextual and that using cases can stimulate learning and encourage group interaction. Finucane et al. described PBL as “an educational method characterized by the use of patient problems as a context for students to learn problem-solving skills and acquire knowledge about the basic and clinical sciences” (p. 445).

As an instructional methodology, PBL incorporates many elements from adult learning theory and helps students gain knowledge and develop the skills, attitudes, and habits to perform competently in a chosen field. Donner and Bickley write that,
in health professions education, “The PBL student must acquire a body of basic biomedical knowledge equivalent to that learned in a traditional curriculum, the student must learn to apply this basic knowledge in patient care, and the student must acquire the attitudes, habits, and techniques of a lifelong learner” (p. 295). Lohman and Finkelstein18 found that PBL is most effective when the problem is clearly formatted and broken into smaller segments. This may be appropriate in dentistry because a technical procedure can be segmented and presented in “chunks” through a case study.

Outcomes research on PBL has examined satisfaction among students and faculty, performance on Canadian and U.S. medical licensing examinations, peer evaluation, personal reflection, and analysis of student projects, and the results have been mixed.12,19-21 Students and faculty members appear to enjoy the active participation, and there is some evidence to suggest that PBL fosters lifelong learning.12,13 There is little evidence that PBL curricula are better outside a limited number of studies using small groups. Studies13,22,23 have reported that PBL curricula cover approximately 80 percent of what could be accomplished in a conventional curriculum in the same period.

Fincham and Shuler24 described the challenges of PBL in dental education and concluded that while PBL may hold promise, other methodologies may be more effective. Roberts et al.17 found no significant differences in outcomes between students engaged in a PBL program and those engaged in a large-class integrated learning activity that is patient-, case-, or project-based. Case-based learning has been utilized by legal and business educators since the late 1800s. CBL requires the use of cases to teach about realistic patient care situations by asking students to draw from their established foundation and make decisions about problems they may encounter in practice. Donner and Bickley18 posit that, of the 100 medical schools claiming use of PBL in the curriculum, most were actually utilizing case-enhanced teaching, an approach closer to CBL. Major and Palmer12 note a benefit shared by PBL and CBL: “students who acquired knowledge in the context of solving problems have been shown to be more likely to use it spontaneously to solve new problems than individuals who acquire the same information under more traditional methods of learning facts and concepts through lectures” (p. 3). Williams25 argues that CBL and PBL share important characteristics, but differ in key ways. According to Williams, CBL is effective for students who have already acquired foundational knowledge, whereas PBL invites the student to learn foundational knowledge as part of researching the clinical case. Williams sees PBL as primarily student-driven whereas CBL is a collaborative endeavor, in which the faculty member is more intimately and directly involved in the development of the experience and thus in the learning.

Richards and Inglehart26 also distinguish problem-based from case-based learning. Whereas the case itself is the defining characteristic of PBL instruction and determines the process of knowledge acquisition, CBL can be used in multiple ways. They write: “At its most basic, [in CBL] instructors may use a clinical case to raise awareness about a specific issue, dramatize the importance of a particular health problem or treatment strategy, or introduce a topic. At the other end of the spectrum, students can document their clinical care of patients and present it to other students and clinicians in case-based comprehensive care seminars” (p. 284). Like PBL, outcomes research on CBL is inconclusive. In a 2012 systematic review, Thistlethwaite et al.27 reported that students and faculty enjoy CBL and believe it contributes to learning, but that empirical evidence to support the effectiveness of this approach in health professions education has yet to be presented. Studies28-30 have also shown that CBL may be a good adjunct to traditional lectures and that students enjoy this format and are better prepared to engage in conversation during class sessions by asking questions or making appropriate topical comments. Unlike the traditional curriculum format in which one discipline could be presented to a large group of learners, the use of problems or cases necessitates the combination of multiple disciplines in addressing each problem or case so a brief discussion of multidisciplinary teaching will help round out this discussion.

**Multidisciplinary Teaching**

In dental education, the movement away from a siloed curriculum to a multidisciplinary approach that integrates basic science foundational knowledge more closely with clinical practice, as recommended in the IOM3 and ADEA CCI4 publications, has direct implications for the application of a CBL approach. There is clear and growing recognition that dentistry, as a surgical field, requires high-level thinking skills. This is reflected in recent changes to accreditation standards31 and competency statements
for the general dentist. Students must be able to access, synthesize, and apply knowledge to new and novel problems. In educational terms, students must be able to function at the level of “synthesis” described by Bloom. Studies have suggested that a multidisciplinary case-based approach may lend itself to the synthesis of information and evaluation of outcomes that support the type of learning necessary in dentistry.

Movement toward the integration of biomedical science foundation knowledge into larger multidisciplinary courses is occurring in dentistry and encourages the use of CBL as an instructional methodology. Multidisciplinary teaching is most effective when it is grounded in clinical practice and when it engages both learners and faculty in critical thinking as they apply knowledge to complex problems of practice. Allen and Moore offer an excellent example of multidisciplinary teaching implemented at New York University College of Dentistry. They describe a methodology that emphasizes “an integrated approach to data collection, interpretation, and clinical decision making” that centers student learning and faculty work within “the context of general dentistry and clinical problem solving” (p. 469). They report that this approach requires faculty members to move outside of their specific disciplinary specialty, to acknowledge “lack of awareness of content in other areas” (p. 472), and to work together to ensure that genuine collaboration among faculty and students is occurring. Their report underscores that multidisciplinary teaching has enormous potential to promote collaboration between faculty members from different fields, such as behavioral and biomedical sciences, in the clinical education of health professions students. In addition, Richards and Inglehart found that multidisciplinary approaches to teaching provide students a deeper appreciation of the complexities of treatment planning and diagnosis. This teaching style can also help students learn and understand the importance of topics important to the competent delivery of oral health care, such as cultural sensitivity.

Case-based learning, as part of a multidisciplinary approach, has received affirmation from learners and facilitators, and research has shown a positive relationship with the development of clinical skill. In order for CBL to be effective, however, certain issues must be addressed. Some evidence suggests that expert discussion leaders are necessary to provide students the deeper understanding of foundational knowledge when taking on CBL as a learning modality. Faculty members must be trained to lead discussion groups. Case-based learning relies heavily on students having a foundational understanding of previous studies of relevant disciplines in order to fully understand and solve the issues and problems presented in the case. Faculty must be aware of these prerequisites and work intentionally on developing the capacity of students in order to take full advantage of this teaching methodology. Hay and Katsikitis note that “students need to be brought up to speed on what the expectation is for their preparation and participation. Without this assistance, they may have difficulty in following through and really integrating the material if they are left on their own to gather and synthesize the material” (p. 23).

According to Howard et al., curricular change is grounded on the premise that “dental school curricula inherently incorporate a multiple-discipline theme leading to one common goal: to graduate knowledgeable and competent dentists” (p. 963). Similarly, Richards and Inglehart have claimed that multidisciplinary learning may be more successful than traditional teaching in preparing students for higher order cognitive skills such as critical thinking and problem solving. As they write, “In particular, treatment planning may be most effectively taught using an interdisciplinary approach and not merely within the confines of specialty departments” (p. 286).

**Conclusion**

Curriculum reform in dental education continues, and dental schools report movement toward a more integrated, multidisciplinary model that makes transparent the important relationships between basic and clinical sciences. As noted in this article, problem-based and case-based learning have been described as promising tools for medical and dental educators. Based on our review of this information, we recommend the use of multidisciplinary teaching to support case-based learning as a promising andragogy for teaching oral health knowledge, skills, and dispositions. This foundation was used to develop an integrated, multidisciplinary, student-centered curriculum at the University of the Pacific Arthur A. Dugoni School of Dentistry, called the Pacific Dental Helix Curriculum. The development and implementation of this curriculum reform were reported in a separate article in the *Journal of Dental Education*. Initial outcomes of this curriculum reform will be...
described in future articles. We acknowledge that there are challenges and risks in deploying changes to the management of dental education described here. Multidisciplinary teaching requires a change in the organizational culture and closer collaboration between academic disciplines, which may take time and require political capital.

The transition towards PBL or CBL requires additional faculty resources as well. Small-group facilitated learning places additional strain on faculty time that will likely require additional FTEs or the reallocation of duties. The change in methodology also requires that faculty have the appropriate development opportunities to prepare for, facilitate, and assess student learning in the PBL or CBL format. Finally, one often-looked-over challenge is in continuing to recruit and matriculate students who will succeed in a more engaging learning process. However, we believe that, by blending the findings from the literature on adult learning theory and CBL, and PBL as outlined here, the goal to offer a multidisciplinary case-based learning curriculum remains a viable model for reforming the predoctoral dental curriculum.

REFERENCES


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