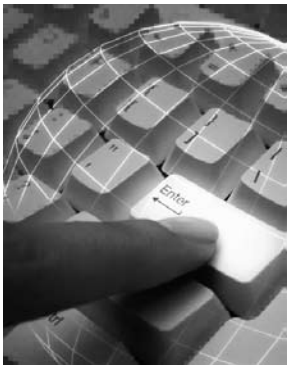

"Blending" Technology and Effective Pedagogy in a Core Course for Preservice Teachers

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Abstract

An instructional team at a public university redesigned a large "core" course in special education required of all undergraduates in a teacher education program. The new design, which blended online instruction with face-to-face meetings, operationalized key principles from Adult Learning theories and Universal Design for Instruction. Students' online interactions as well as their comments and scores on the final course evaluation reflected high degrees of satisfaction with the new delivery approach. Student and instructor insights inform recommendations for college faculty seeking to integrate instructional technology into their own core courses as well as suggestions for future research.

Introduction

Instructors who teach large undergraduate courses, including teacher preparation programs, have reported struggles when trying to provide meaningful learning experiences to students in these "core" classes. Logistical and budgetary constraints can necessitate that such courses be taught to sizable groups of rapidly disaffected students in impersonal lecture halls. This approach to course delivery can severely limit students' ability to engage in meaningful discussions, apply course concepts to practical classroom situations, or create personalized learning communities with peers and instructors (Garnham & Kaleta, 2002; Johnson, 2002; Matthews, 2002/2003). Faced with similar challenges at their large public university in the Northeast, the authors sought to increase the wise use of instructional technology that facilitated learning in a "blended" course by combining face-to-face and online experiences (Dukes, Waring, & Koorland, 2006; Johnson, 2002; Marsh, McFadden, & Price, 2003). These efforts became a pilot for making pedagogical decisions using key principles from Adult Learning (AL) theories and Universal Design for Instruction (UDI). The positive outcomes, summarized and discussed here, may be of interest to instructors and designers of similar courses.

The authors focused their efforts on a course the lead author had been asked to redesign. EPSY 207 ("Exceptionality") is a 2-credit introduction to special education course that is required of all first year students (juniors). The lead author had been tasked by his program to redesign the course to more fully engage the approximately 120 students who take it each year and to enhance opportunities for special education and general education majors within the course to practice team-based approaches to educational decision making. As the result of the Individuals with Disabilities Education Act of 1997, general and special education teachers increasingly collaborate to educate students with exceptional learning needs in inclusive settings (Shippen, Crites, Houchins, Ramsey, & Simon, 2005; Wehman, 2006). This systemic change in how and where schoolchildren with disabilities are taught is one of several practical reasons why education majors are required to take "core" special education courses together in preservice teacher education program**s**, including the program in which the authors teach. One aim of such courses is to provide students with opportunities to learn from one another via critical reflection on policy and pedagogical issues that transcend the unique concerns specific to any one grade level or content area (Ochoa & Meta Robinson, 2005). A particular goal of many special education core courses, including EPSY 207, is to provide engaging learning experiences that enhance students' development of the skills and beliefs needed to implement effective inclusive practices in their future careers as educators (Campbell, Gilmore, & Cuskelly, 2003; Miller & Losardo, 2002).

Theoretical Framework

The first and second authors met in person and interacted electronically during the fall semester to plan the spring course. Their discussions involved scaffolding each other's learning since the lead author had expertise in special education and the second author had expertise in the integration of technology and working with adults. The second author, a doctoral student in the Adult Learning program at the university, also taught sections of the instructional technology course all School of Education juniors take in the fall semester prior to EPSY 207. Her graduate assistantship, which was overseen by the third author, was designed in part to provide technology training and support to faculty members. She and the first author continued to meet at least bi-weekly during the semester when EPSY 207 was taught. The third author met with the instructional team periodically during the fall and spring semesters to offer feedback, support, and resources. These collaborations were informed by the cognitive apprenticeship model proposed by Brown, Collins, and Duguid (1989), although not all of the tenets were followed. At the end of the spring semester, the course Web site was archived to retain student interactions for analysi**s.**

The authors drew upon Adult Learning (AL) theories to create meaningful learning experiences and the principles of Universal Design for Instruction (UDI) to establish a welcoming environment that anticipated students' diverse needs, interests, and abilities. Recommendations from AL theorists, who offer a framework for distinguishing between the learning needs of adults and children, provided initial guidance as the instructional team discussed viable course assignments. These theories seek to identify the characteristics of adult learners and how best to meet their learning needs. In general, AL scholars view adults as autonomous problem solvers who seek out experiences that can enhance their proficiency (Merriam & Caffarella, 1999). Brookfield's (1988) work on critical thinking synthesized the writings of other AL theorists who suggest that adult learners exhibit diverse learning styles, prefer their learning activities to be problem-centered and applicable to their own life situations, bring previous experiences to current learning activities, exhibit a tendency toward self-directed learning, and develop linkages between their learning experiences and self-concepts as learners.

Whereas AL theory guided the creation of course activities, principles of Universal Design for Instruction (UDI) informed the authors' efforts to cultivate a positive learning environment. Interestingly, the inspiration for UDI comes from outside education. Reflecting a growing societal appreciation for human diversity that began in the 1970's, many architects and engineers now incorporate the principles of Universal Design (UD). Practitioners of UD, pioneered by Ronald Mace at North Carolina State University, anticipate diversity when designing buildings or products that are immediately "usable" by the greatest number of people possible (Center for Universal Design, 1997). Curb cuts in sidewalks and automatic doors, for example, proactively ensure that parents with infants in strollers, delivery people, and individuals who use wheelchairs can easily enter and leave otherwise inaccessible buildings. Researchers in postsecondary education for students with disabilities have more recently applied this theory to the design of instructional environments in college classrooms, known as Universal Design for Instruction (UDI). Scott, McGuire, and Shaw (2003) defined UDI as "an approach to teaching that consists of the proactive design and use of inclusive instructional strategies that benefit a broad range of learners, including students with disabilities" (p. 169). This research team recommends that college instructors infuse UDI principles into course development or redesign in order to make learning as accessible to as many students as possible without the need for "retrofitted" accommodations such as notetakers (Scott, McGuire, & Embry, 2002). For a fuller discussion of this theoretical framework and to view examples of faculty products that reflect UDI principles, see http://www.facultyware.uconn.edu.

While the melding of AL and UDI principles created a theoretical basis for decisions about the use of technology in EPSY 207, the instructional team lacked a tool for overcoming the previously stated constraints of a large, lecture-driven course. Technology offered viable solutions only if it provided opportunities for meaningful interactions and community building, allowed students to engage in self-directed learning experiences that enhanced their knowledge about special education, and achieved these goals without overwhelming an instructor who had limited experience with instructional technology and multiple demands on his time. The authors decided to use a course management system (CMS) to blend an online component with traditional "in-person" class meetings.

According to Maslowski, Visscher, Collis, and Bloeman (2000), a CMS has the potential to extend the benefits of a good instructor and friendly campus environment by increasing the flexibility and level of student engagement and personalizing the contact between and among students and instructors. The authors considered guidance from several researchers as they infused technology into the design and delivery of the new course. Chou (2001) emphasized the need for responsive instructor guidance and guidelines that govern small group chats. Murphy and Collins (1997) stressed the need to provide a safe and trusting learning environment where appropriate levels of sharing could occur. Sotillo (2000) cautioned instructors to expect a decrease in the amount of control they would have over the learning environment when utilizing a CMS to support students' learning activities. The authors remained cognizant of the fact that the very term "interactivity" has different meanings (Bannan-Ritland, 2002), particularly between students and instructors (McIsaac, Blocher, Mahes, & Vrasidas, 1999).

Course Design and Delivery Decisions

This 2-credit course met face-to-face on a weekly basis as a large group (114 students) for 1 hour 40 minutes. The instructors divided students into smaller online teams of approximately nine students each. Eight assignments during the 15-week semester, accounting for 75% of the class grade, required students to collaborate in between lectures in order to be successful. Each team was assigned a separate case study focusing on a hypothetical student with exceptional learning needs (e.g., Attention Deficit/Hyperactivity Disorder, cerebral palsy, Gifted and Talented). Teams consisted of students from different concentration areas such as social studies education, elementary education, and music education to expose them to the diversity that characterizes actual school-based planning teams. All teams included at least one student majoring in special education. Students were to organize their groups as an Individualized Educational Planning (IEP) team and immerse themselves in an extended role play as they developed their case across the semester. Students chose roles for themselves that reflected actual participants who might realistically serve on the hypothetical student's IEP team, such as the school principal, parent, student (depending on age), school psychologist, Special Education teacher, and regular education teacher, among others.

The instructor provided teams with five different prompts throughout the semester (e.g., "Using formal and informal assessment data, determine the top academic need and top non-academic need that should be the focus of this student's IEP."). Teams then discussed the prompt in person and online with consideration of course materials, outside sources such as notes from related courses and Internet resources, and observations from their school practicum experiences. Analysis of the CMS confirmed that 100% of students participated in online discussions and that 98% contributed original content to the threaded discussion for at least one prompt. Each team then posted a 2–3 page summary of their discussion and decisions in response to the prompt. As a culminating activity, each case study team created an IEP for their student using the state-approved form and decisions made about the student in the earlier team summaries. Five percent of a student's final grade reflected the average of scores anonymously provided by all other team members on the last day of class, rating that student's collaborative participation as a team member.

Students also were responsible for two individual assignments. First, they were asked to find a Web site that provided legal, disability, family/cultural, or IEP roles/process, or life stage (early childhood or transition) content with direct relevance to their case study. Using an evaluation rubric adapted from Salend (2005), students rated the Web site's accessibility and its applicability to their case study. Second, each student was responsible for finding a practitioner's article in a teacher magazine that provided assessment or instructional intervention content with direction relevance to their case study. Using an instructor-provided rubric, students again were asked to evaluate the viability of recommending this article to colleagues or parents in their future roles as teachers and to apply content to their case study.

Each class typically began with announcements from the instructor and students alike and often included demonstrations of how to use relevant functions of the course's CMS Web site. Weekly in-person activities included brief lectures, guest speakers, time to watch and discuss videotapes, quizzes, and team meetings. Five unannounced quizzes that could not be retaken were given throughout the semester and resulted in 20% of a student's final course grade. Quizzes were used to assess students' mastery of course readings and lecture materials. Each student's lowest quiz score was dropped from the final course grade to encourage attendance without unfairly penalizing busy students during the long winter semester.

The instructor posted assignment rubrics and weekly PowerPoint slides to the CMS Web site. In addition to "public" spaces that all students could access on the Web site, each team had its own section for posting case study discussions, drafts, and completed assignments. While students were not required to make a specified number or type of posting, they were repeatedly encouraged to exchange questions, resources, drafts, and feedback there so that the instructional team could offer comments, support, and timely feedback. With permission, the instructor posted exemplars of various teams' work samples throughout the semester after highlighting these examples in class. In addition, students were repeatedly informed that 5% of their final course grade would reflect the average "collaboration" rating privately assigned to them by all their fellow team members during the last week of classes.

Outcomes

Analysis of student online interactions and course evaluations produced examples of how the Web-enabled course design created an environment that helped instantiate both the AL tenets and the UDI principles discussed earlier. The authors make no causal claims, nor purport to know which features of the design (AL tenets, UDI principles, use of the CMS) contributed to the positive learning outcomes. However, ongoing observations and analysis of student discussions, products, and feedback advance the view that these strategies *together* conspired to create positive solutions for many of the challenges inherent in a large, lecture-driven "core" classroom environment. Salomon, Perkins, and Globerson (1991) referred to this inability to isolate individual factors as a "cloud of correlated variables." The new approach to course design and delivery provided opportunities for practical or applied learning activities and critical reflection within a community of practice**,** enabled self-directed learning**,** and facilitated the development of a respectful environment. At the same time, the new course design facilitated the implementation of many UDI principles. What follows is a description of four specific ways that the Web-enabled course supported the instructional team's adherence to these tenets and principles.

First, the design fostered students' engagement with the AL tenet of *practical, applied learning*. Students repeatedly utilized the CMS Web site to develop their case studies throughout the semester. This problem-centered approach provided students with immediate ways to apply course concepts (Knowles, 1990). By creating electronic access to resources and offering ongoing, supportive feedback to students about their drafts and final products, the instructors created a "safe" environment for risk taking given students' developing knowledge about special education. Rather than simply testing students on their declarative knowledge of course concepts, the case studies provided students with multiple opportunities to apply their emerging knowledge about special education issues to scenarios that were similar to students in real classroom situations they were observing each week in their clinical placements.

At the same time, using the CMS to develop case studies reflected the UDI Principle of Equitable Use (#1—Instruction is designed to be useful to and accessible by people with diverse abilities) by enhancing all students' access to myriad resources such as lecture notes, links to Internet resources, and peer discussion threads. Anticipating a range of prior knowledge that the 114 students would have about special education issues and the likelihood that some would be more comfortable raising questions or comments online than in person, the Vista Web site supported students' exchange of practical information they could apply in multiple settings. As an example, one student studying to become an English teacher posted the following comment about the utility of an article she had found to evaluate and apply to her case study (all student examples in this article are reproduced verbatim). She had used a link on the course Web site to locate an online journal for teachers who work with students with disabilities. Her post conveys the seeds of a personal rubric she will be able to use as a future classroom teacher when selecting resources to support her inclusive instructional practices:

> The article I've chosen is 'Considering Placement and Educational Approaches for Students Who Are Deaf and Hard of Hearing.' by Barbara Fiedler (from Teaching Exceptional Children". I feel this article will be very useful in that it provides questions and lists to use when determing what educational placements are most appropriate for students with hearing problems.

The CMS also helped instructors implement the UDI Principle of Tolerance for Error (#5—Instruction anticipates variation in individual student learning pace and prerequisite skills). Across the semester, five instructional prompts required students to engage in iterative discussions about their case study. Students could return to earlier discussion threads and review prior lecture presentations on their own as they composed their responses. Case study teams were invited to share early versions of their responses to each prompt with the instructor, who would then offer written feedback about the drafts' quality and content. They were also encouraged to exchange questions and opinions with one another via the widely-accessible course Web site. Students often clarified misinformation, answered their peers' questions, and respectfully challenged points of view as instructors joined these online discussions. On the final course evaluation, one student who did not major in special education offered the following appraisal about his/her understanding of new concepts learned in this course:

> I just wanted to share that yesterday in clinical I had the opportunity to observe and take part in a Dutch research team's exploration of how to integrate special education into the public school environment. For the Netherlands there are separate schools. A few researchers asked me many questions related to concepts we learned in class and I realized I was knowledgeable and not afraid of special education!

Second, the design supported students' application of the AL tenet of *self-directed learning*. According to Cross (1981) and Grow (1991), adults are autonomous and self-directed learners. Students had a great deal of choice about when and how they could engage in learning activities. They could access course content and interact with peers and instructors online, for example, in a manner that was congruent with their individual learning styles and needs. By making assignments, announcements, directions, and exemplars available in the syllabus, in class, and on the Web site, the instructional team offered students a great deal of learning autonomy. The incorporation of PowerPoint presentations, videos, demonstrations of disability characteristics and assistive technology devices, and discussions during the in-class meetings also supported the personal preferences of students who may have learned best in "live" settings.

In making course content available in person and online, the instructional team also adhered to the UDI Principle of Minimizing Physical Effort (#6—Instruction is designed to minimize nonessential physical effort in order to allow maximum attention to learning) and the UDI Principle of Perceptible Information (#4—Instruction is designed so that necessary information is communicated effectively to the student, regardless of ambient conditions or the student's sensory abilities). CMS's are inherently flexible because they put all relevant information in one place, making it easier for students to access. Using instructional technology in this way minimizes or reduces students' need to physically go to the library or other locations to obtain resources. In addition, students do not have to make the sometimes-difficult decision about perceiving the most salient information. If information is important, the instructor has posted it on the course site. Students then have many choices regarding how they wish to view that information in a format that meets their personal needs or preferences (e.g., enlarged font size, multiple screens opened at once, viewing information on screen or downloading a printed copy). While presenting information to 114 students in a large lecture hall, the instructor often projected content from the course Web site onto monitors around the room. This allowed him to reinforce salient information and freed him to leave the lectern area in order to circulate and interact with students in a more personalized manner.

One student spoke to UDI Principle 4 by writing on the final course evaluation, "The teacher did a great job of using different mediums throughout each class to maintain attention and stimulate interest. He also was constantly moving about the room maintaining eye contact with students which showed his concern for comprehension." Another student demonstrated a self-directed approach to "dividing and conquering" the

extensive work required to develop the case studies, which minimized the physical effort required of any one student in her case study team to complete the group assignment. In the process, she illustrated how the CMS allowed the instructional team to incorporate UDI Principle 6:

> I suggest splitting up the assignments so that we work in partners and are accountable for submitting one assignment. To make sure all are covered, please sign up for one (the dates were listed in the last posting I did). [Student name] and I are doing the first one. If you have any suggestions please post them asap. Before we submit the team assignment, we will post it here and anyone can add/review it. We will submit it on Sunday. Let's meet after next Thursday's class for 5 minutes (at the front where we met the first day) to make sure we are still on the same page about our next assignments.

Third, the design encouraged students' *critical reflection* as they built their own *communities of practice,* both of which are key AL tenets. Throughout the semester, each case study team posted brief executive summaries in response to instructor prompts. These assignments served as a common problem for each team to solve via discussion, negotiation, and utilization of resources (Kolb, 1984; Mezirow, 1990). In the process, teams developed cohesion as they became smaller communities of practice within the larger class of 114 students. In this way, the team summaries allowed the authors to practice the UDI Principle of Community of Learners (#8—The instructional environment promotes interaction and communication among students and between students and faculty).

Two students posted comments that can exemplify how the CMS supported students' engagement in collaborative learning activities that welcomed different points of view. The first student, a math education major, applied this principle by empathizing with the parent whose perspective she adopted throughout her case study. The following post illustrates how deeply she has reflected on a complex scenario and the comfort she feels in expressing her point of view and seeking input from others:

> Marcus' ability to spell words at grade level could be a strong formal assessment argument to support his parents' desire for inclusion. If he is at the same level as his peers in some areas, they would argue that he should be included in those areas. I believe that his parents would probably support partial inclusion with some time spent in a resource room. They have invested so much time, money, and energy to give him access to any therapy he might need. They enrolled him in an early childhood program to recieve physical, occuplational, and speech therapies, and also provided him with a special aide at the Jewish private school. These services should continue to be offered, and Marcus could access them during school hours, by visiting the occupational or speech therapist in a resource room for a short period each day. I think his parents would want him to have this opportunity and also be included as much as possible. What does everyone else think?

Another student posted a reflection about the five team summaries and how these assignments facilitated her team's positive collaborations. In contrast to the task-focused example above, this example illustrates how the new course design and instructional pedagogy shaped the creation of smaller learning communities in which students engaged in collaborative learning activities that supported their professional growth:

> Thanks for posting our final draft [student name]. I just wanted to thank the group for all their hard work. We all got along exceptionally well and I think we all did a great job putting it together. I will be very priveleged if I get to work with any of you in the future. Good luck on finals!

The design incorporated tools that helped the instructional team adhere to a final AL tenet, which involves developing and maintaining a *respectful environment*. In particular, the instructors were able to provide positive and timely feedback that supported students' learning experiences and outcomes. The relationship between the educator and learner influences the extent to which an environment facilitates learning (MacKeracher, 1996). Knowles (1990) described a respectful, safe learning environment as one that accommodates both physical comfort and human relations. A trusting relationship between educator and adult learner is essential to such an environment. Vella (1994) suggested that this evolves by respecting the learner; listening attentively; engaging in open, affirming, non-judgmental behavior; providing clarifications of the learner and educator roles; and using dialogue to develop the relationship.

By modeling professional language when responding to questions and competing points of view, positively commenting on students' conscientious efforts, and sharing student exemplars to illustrate and clarify assignments, the instructors set a motivating tone. In the process, the instructional team adhered to the UDI Principles of Simple and Intuitive (#3—Instruction is designed in a straightforward and predictable manner, regardless of the student's experience, knowledge, language skills, or current concentration level) and Instructional Climate (#9—Instruction is designed to be welcoming and inclusive). The course assignments were clearly described and posted on the Vista Web site with due dates. Instructors repeatedly demonstrated, at the beginning of the semester, how to use simple icons to locate course materials and assignments. In traditional courses, students can miss assignments because they misplaced a handout, had to miss a class, or simply did not hear an announcement in class. The latter can be a particular problem for students with hearing, learning, and attentional disabilities. Posting all relevant course materials on the CMS had the benefit of proactively addressing these students' needs and modeling how all of the future teachers could utilize technology to do the same for their students.

In preparing to become teachers themselves, the students offered many comments on the final course evaluation that reflected their appreciation for the modeling that shaped a learning environment in which they had taken risks, collaborated with one another, and expanded their content knowledge and skills in this core course. One student commented on the instructional climate by writing, "[The instructor] was always concerned and interested in the progress & development of his students. He genuinely cared about us & our ideas and was very respectful."

The overall rating of the course based on student evaluations was a mean of 9.2 on a 10-point scale, with 10 being outstanding. This rating was a significant improvement over previous attempts to present special education content to preservice teachers in a core course. During the same semester, the overall mean score on undergraduate course evaluations in the same department was 9.1 and 8.7 for the entire university. Nearly all (102) of the 114 students who registered for this course completed the final course evaluation. One-third (33%) of the evaluation completers took time to add comments about the use of instructional technology in EPSY 207. All of these comments conveyed students' appreciation for the availability and use of course-based technology tools. One student noted, "Powerpoints put online before each class – very helpful so we could listen more and just jot notes on the already prepared notes." Qualitative data gleaned from course evaluations and online discussions afforded the instructors with formative and summative data about students' positive responses to course content and learning activities and affirmed the benefits of their own use of the cognitive apprenticeship model.

Discussion

This article reports the positive learning outcomes that emerged from an instructional team's decision to use key tenets from Adult Learning (AL) theories and Universal Design for Instruction (UDI) to guide their use of technology in a large, preservice teacher education "core" course. This piloted approach to course design and delivery allowed the authors to overcome many barriers associated with the traditional lecture-only methodology. The use of a CMS provided meaningful glimpses into the interactions between members of each case study team. Team areas on the Web site allowed students to interact with one another and the instructor in order to ask questions, apply course content, and offer suggestions and encouragement. This form of electronic discourse supported and reflected positive communities of learners/practice and is exemplified by the following student comments: "[The instructor] utilized the technology available in a very positive way. By giving constant feedback on WebCT it was reassuring that he was showing constant involvement & assistance in our assignments throughout the semester," and "I was amazed with the speed you responded on WebCT and to emails."

The affective dimensions of pedagogy that foster an inclusive community of learners in a large core class can be enhanced with online technology (MacKeracher, 1996; Scott & McGuire, 2006). Using a CMS to facilitate positive interactions amongst students and between students and instructors may facilitate risk-taking in the social learning environment. On the final course evaluation, 38% of students specifically commented on the importance of this environmental quality. As one student wrote, "He as a teacher in our class has modeled what he has tried to teach. His caring and appreciation for the students is a rarity among professors."

Implications

The positive outcomes reported in this article merit further consideration by practitioners and researchers. First, students' access to technology similar to that which was used in EPSY 207 must be considered. Students participating in the teacher preparation program at the authors' university are now required to purchase laptops designed to enhance their development of proficiency with a variety of instructional technologies. As growing numbers of classrooms and other facilities on their campus begin to support wireless connections to the Internet, these students have increasing opportunities to individualize how, when, and where they access course content in EPSY 207 and other CMS-supported courses. Students with disabilities can utilize text-to-speech software or control visual features such as font size and color to enhance accessibility features when such technology is readily available. Instructors on campuses where student access to computer technology is less available are encouraged to consult with the disability services office and/or any assistive technology services for guidance about enhancing accessible access to online learning.

A second set of related implications involves the need for further research to systematically explore any relationships between AL tenets and UDI principles. To date, there has been minimal discussion in the literature about the interconnectedness of these theoretical positions (DO-IT, 2005). The authors found that using a CMS appeared to facilitate pedagogical practices that integrated AL and UDI principles. Additional studies are needed, however, to more fully explore relationships between these theoretical constructs. Speaking to similar issues involving the broad framework of Universal Design, McGuire, Scott, and Shaw (2006) observed:

> The fields of architecture and design have called for the development of a "critical theory" of UD (Welch, 1995) involving the testing of suppositions (i.e., UD principles), engaging in serious discourse and critical practice, implementing ongoing projects to document exemplars, and refining and validating the UD principles (p. 172).

Should empirical findings depict any meaningful relationships between AL and UDI, more research is needed to study the impact that technology-infused course built on these theoretical foundations may have on student access, engagement, and learning outcomes.

In closing, the mentoring connection between the course instructors led to a synergistic relationship that enhanced the use of learning technologies while keeping the class focus on special education. Design team members informally concluded that they had grown in areas in which each previously had limited domain knowledge (Brown, Collins, & Duguid, 1989). In this way, the use of technology resulted in positive learning opportunities for students and instructors alike. Future research about the application of this model to the development of core courses could support a growing number of college instructors who possess expertise in their own content areas but lack the time or temerity to "take the technology plunge" on their own.

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