Chapter XXXV
Redesigning a SAD Course to Promote Problem-Based Learning

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ABSTRACT

This chapter reports on the design, development, and implementation of a hybrid introductory systems analysis and design (SAD) semester long course taught at the junior/senior level. Five online instructional modules that focus on student-centered, problem-based learning (PBL) were developed. Each module parallels and reinforces the classroom session content. The classroom "seat-time" saved by having students study and complete online materials provides the instructor and students with additional time for face-to-face and electronic discussions. To further encourage PBL throughout the semester, students use an iterative approach to the SAD life cycle to analyze, design, and implement a prototypic solution to a real world problem presented by the authentic client. The use of a learning management system allows the client to participate in the course throughout the semester regardless of the physical distance between the students and the client. Instructor experiences, hybrid module development strategies, and a summary of student and client feedback are included.

INTRODUCTION

Systems analysis and design (SAD) courses typically introduce students to the fundamental principles used in this disciple area and provide students with an opportunity to demonstrate their understanding of these principles through a project that requires the development of a software product. This allows students to examine, practice, and demonstrate understanding of each phase in the system development life cycle.

The 15 week introductory junior/senior level SAD course discussed herein is required for all computer and information science, computer engineering, and computer management information science majors. Two sections are typically taught during the year with 20-25 students enrolled in each section. In the past, it has been taught in a traditional, face-to-face environment with instructor-centered lectures. Students worked in groups, composed of four to five students each during the semester and

used systems analysis and design theory presented in the classroom to develop a prototypic software product for an instructor-selected fictitious problem. The instructor's role in this environment was one of knowledge dissemination rather than a facilitator of learning.

While it was clear that students benefited from instructor feedback throughout the semester, it is apparent that the time available using this paradigm for in-depth discussions between the instructor and individual groups was at a premium. Scheduling conflicts were a perennial problem when attempting to determine suitable student, group, and instructor meeting times outside of the assigned classroom periods. Interestingly, instructor, student, and group time conflicts, as well as difficulty evaluating individual work done within a group, are often sited as the main reasons why computer science instructors shy away from group projects (Brown & Dobie, 1999).

From the students' course evaluations, it was evident that this SAD course format was less than ideal for reaching the course's cognitive goals which focus on developing and using problem solving methodologies and social goals which stress team work and communication. Although Hazzan (2003) reports success in addressing and meeting these goals by greatly limiting the course enrollment, which allowed more time for interactions and reflection, the decrease in credit hour production is not a realistic option for many programs.

The redesign of this course focused on shifting to a student-centered, problem-based learning (PBL) environment. Edens (2000) identifies several characteristic threads of a successful PBL which, in turn, were woven in the framework of this course. These include: 1) learning is student-centered rather than instructor-centered; 2) students consistently work in small groups; 3) the instructor serves as a facilitator rather than a lecturer; and 4) problems are the focus, the stimulation for learning, and serve as the tools by which students develop problem solving skills.

It is evident that the PBL model signals a radical paradigm shift from the traditional instructor-centered classrooms to a classroom that is group-centered and stresses the development, implementation, and demonstration of higher level cognitive domain skills. The importance of infusing PBL into course design is succinctly summarized by Gibson and O'Kelly (2005) in this way: 1) Students are encouraged to think critically when analyzing and solving complex, real-world problems; and 2) Team work serves to develop and enhance participants' group skills including effective oral and written communication. While PBL and cooperative group work (Johnson & Johnson, 1989) are employed in numerous mathematics and science and engineering programs as tools to promote higher order cognitive skill development (Mehrens & Lehmann, 1984), Chinn and Martin (2005) indicate these techniques have not been readily been promoted in computer science classrooms.

At the core of this SAD course redesign are two complementary components that utilize our Web-based learning management system (LMS), Desire 2 Learn. First, a series of online course modules were developed to support learning through student participation in activities that encourage problem analysis and synthesis and interactions between classmates, group members, and the instructor. These modules parallel and reinforce a related classroom component and the phases within the SAD project development cycle. This approach shifts the responsibility of learning from one that is dependent on the instructor to that of being a shared commitment between student and instructor. The online modules are designed to be completed outside of a classroom setting. The "seat time" saved by delivering almost half of the course content online is used by groups for project-related meetings and by the instructor to provide more in-depth feedback and one-to-one interactions, both electronically and face-to-face, with students and groups.

During the course's more traditional classroom component, which encompasses approximately one half of the course, emphasis is placed on es-

tablishing a foundation for the three phases (i.e., requirements and analysis, design modeling, and prototype implementation and testing) of the system development life cycle and group presentations that summarizes their progress at the end of each phase. Calongne (2002) reports that while effective teams and interaction between team members in an online software engineering classroom is highly desirable, many students dislike team projects where there is no face-to-face interactions. The hybrid course pedagogy discussed above, where half of the course content is delivered online and the other half in the classroom, provides ample opportunity for the development and practice of successful online and off-line group communication.

Besides providing the student with access to the online modules, the LMS discussion forum and document repository area are designed to give students, groups, and the instructor additional communication routes throughout the course (Sheard, 2004).

The second component of the course redesign involved the incorporation of a virtual, authentic client who provides the class with a "real world" problem from the student's business environment. The problem, in turn, requires each group to develop, using SAD principles, a prototypic software product which evolves throughout the semester. The integration of an authentic client and problem adds a very powerful learning dimension to the course, that is, a real problem that requires a real solution. Polack-Wahl (1999) reports that prior to the advent of the Web and its resources, providing students with such real world experiences was a daunting task and often not worth the effort. With the help of a LMS, the virtual client can actively participate in the class through online discussions and participating in FAQ forums. Since students and their respective groups are required throughout the course to store course-related documents in their LMS document repository, the client may also observe and comment on work throughout the project development process (Polack-Wahl, 2001).

To some faculty, the idea of persuading an actual client to virtually join a course may seem like a daunting task. Alumni, advisory board members, and interested business partners who actively recruit and hire our program's students as interns or for full time employment have proven to be excellent resources.

Three overarching benefits are derived by delivering almost one-half of the course online and incorporating a virtual authentic client/real world problem. First, the reduced seat time allows the instructor additional time to engage in more and deeper student/group interactions throughout the semester. Second, the student groups formed early in the semester are able to use available class time to meet online or face-to-face to discuss and plan their project development. Third, active engagement in PBL provides students and the instructor with a powerful environment for learning.

Student course assessments indicate the implementation of a hybrid course which embeds PBL principles, coupled with an authentic client/problem, greatly enhances the student's understanding of: the software analysis, design, and development process; the bridge that exists between theory and practice; and the need for developing individual as well as group communication skills. Overwhelming support for this type of course has been obtained from all participating clients.

RATIONALE FOR DEVELOPING A HYBRID COURSE

Systems analysis and design courses, whether taught in a face-to-face or hybrid environment, typically address both cognitive and social aspects of learning. Cognitive course goals focus on students' understanding of the key principles behind the system development process and their ability to use this knowledge to guide the development of a solution for a given problem.

Because large problems may require a great deal of time to produce a viable solution, student groups

or teams are often formed. Teams, which attempt to emulate an authentic work environment, provide a means to address social aspects of the course, thus concentrating on developing cooperative group and project management skills.

Having taught this course for several years in a traditional environment, it became clear that an effective course pedagogy, which addressed both and social goals, could be successfully developed within a hybrid course and yield a significant gain in overall student learning.

Using Smith and Tillman (1999) and Ko and Rossen (2004) as references, this author identified aspects of the traditional course that could be delivered online as well as incorporate a high degree of student-centered, problem-based learning. The class time saved by having students complete these modules outside of class provides the faculty with increased opportunities to:

- Frequently meet face-to-face with individuals and groups to assess progress and offer suggestions in team building and project development process
- Engage students in active discussions outside of physical classroom through the use of online discussion boards and postings
- Promote increased student-to-student group interactions
- Provide rapid instructor electronic feedback to questions, documents, and assignments stored within the LMS's individual and group accounts
- Electronically address and comment on problematic areas in assignments and project development prior to submission, thereby supporting learning and reducing the need for significant revisions later
- Develop a forum for the virtual, authentic client to present the project, respond to questions, and observe student work throughout the semester
- Examine frequently the electronically stored, team reports generated by a team project manager to help monitor and encourage individual participation and contributions to the team project-building process
- Simulate a virtual work environment scenario where team members in diverse locations work together to solve a problem
- Exploit audio and video digital technologies for creating and posting ancillary course material
- Establish and meet virtual office hours

SAD HYBRID COURSE REDESIGN

Net generation students expect instructors to link learning with technology. While five years ago the use of a Web site for posting of assignments and grades seemed adequate, the proliferation of LMS applications on campuses makes it the obvious first choice for course deployment. It has been the experience of this author that the time required for initial LMS proficiency is 30-40 hours. Although there are several LMS vendors, many products have similar components thus less time is often required to reach a proficient usage level on subsequent LMS implementations.

Students also expect the LMS to distribute quality instructional materials. Many universities recognize the importance of excellent online components and support instructional designers to work side-by-side with faculty who, in turn, serve as the subject matter expert throughout the process. Without access to an instructional designer, the burden of course design and development falls entirely on the faculty.

Teaching a face-to-face SAD course several times prior to developing online materials helped this author build a solid understanding of active learning, depth of processing theory, student-centered learning, and group dynamics. As this author gained more experience in the design and development of online material and how students access, process, and learn in an online mode, the online instruction became more diverse and creative.

An instructional designer was not used in the development of the five online course modules. The design, development, and implementation of each module, on average, took 25 hours. This time commitment could be significantly reduced by involving an instructional designer early on and one or more graduate students to identify references and deploy materials to the LMS.

Identifying Modules for Online Delivery

By definition, a hybrid or blended course provides students with both traditional and online instruction. Determining an appropriate amount of time allocated to instruction in each setting is a determination that should be made by the faculty. A practical strategy may include the initial development of a limited amount of materials for online learning. This would facilitate rapid assessment and revision, as needed. Rosbottom and Crelling (2000) observe that with more practice, faculty expertise in designing online modules rapidly increases. As a result, additional online components can be added. These guidelines may help determine what aspects of a course are best suited for online presentation:

- Identify the activities/events that are currently part of the face-to-face class sessions that could be implemented in an online course component. This may include: discussions and lectures in audio, video, or textual formats; problems, case studies, or other scenarios that form foundations for class discussions; cooperative group experiences that encourage and develop team building among individuals in virtual space; and assignments that require the use of software engineering principles, software applications, or project management tools.
- Determine the learning objectives for each identified course component. The more objectives per component, the more complex the activities within the component.
- Assess the amount of class time that could be potentially saved by each identified online component and what the time savings could be used for.
- Establish an assessment strategy for each potential online component.
- Determine the extent of online coursework and face-to-face/virtual team experiences that students possess.
- Identify the type of Internet access most students use.
- Identify the features, file types, and the size of the allocated storage class space that the potential delivery system supports.
- Establish a comfortable balance between student-centered and instructor-led online activities.
- Identify the instructor time and technological resources available for course development.

SAD Hybrid Course Structure

The hybrid course discussed herein is divided into three phases: requirements and specifications, design and modeling, and testing and implementation. Each phase is further subdivided in topic areas that span the 15 week course as shown in Table 1. All topics have supporting online modules except for the group presentations conducted in a classroom setting at the conclusion of each phase. While Jones (2007) suggests that: as academic latency increases, traditional approaches to software development education become increasing irrelevant and as a result IT majors graduate with the theoretical knowledge of the phases and activities in the system development lifecycle but lack the skills required to build useful applications for today's marketplace the pedagogical approach to these modules is simply "doing" systems development from the very start.

Online Module Components and Student Activities

Each online supporting module has four integrated components: advanced organizers, instruction and

Table 1. Overview of the SAD hybrid course

Wk	Phase	Topic
1	Phase I: Requirements and Specifications	Course introduction Significance of project management Introduction of authentic problem and client
2		Team selection Identify requirements and specifications
3		Identify requirements and specifications
4		Project presentation I Refine requirements, specifications for semester problem as needed
5	Phase II: Design Modeling	Process/data modeling
6		Process/data modeling
7		Interface, input, output modeling
8		Project presentation II Refine process, data, interface, IO as needed
9	Phase III: Prototype Implementation and Testing	Develop testing plan
10		Prototype implementation
11		Prototype implementation
12		Prototype implementation
13		Prototype implementation
14		Cross-team testing, refine as needed
15		Project presentation III

examples, student practice, and instructor feedback. The Phase I Requirements and Specifications online module completed during week three of the course is shown in Table 2.

Rather than attending class for up to 4 hours during week three, students complete this module outside of class. Instead of preparing for and delivering four lectures during this week, the instructor may use this time to provide detailed electronic feedback to groups and conduct face-to-face meetings with groups or individuals who appear to have difficulty with the module (Sheard, 2004).

Examples of Phase I Week 3 Requirements and Specifications Module Components and Associated Student Activities

Five examples that illustrate the advanced organizers, instruction and examples, and student practice module components for this phase are presented below.

Phase I Week 3 Advanced Organizer - Learning Objectives

At the end of this phase, each group will be able to:

1. Read the Phase I Case Study and answer the questions below.
   a. *Who* are involved in this problem, opportunity, or directive and what is the role or title of each person?
   b. *What* appears to be the specific issue(s) at the core of this case study?
   c. *Why* does this problem, opportunity, or directive exist?
   d. *Where* is/are the location(s) that is/are impacted?

Table 2. Phase I week 3 requirements and specifications online module components and associated activities

Module Component	Associated Student Activity
Advance organizers	Self-test to determine mastery of concepts needed prior to beginning the activity
	Review learning objectives
	Review a course map that illustrates the relationship of this module to the course
	Module assessment rubric
Instruction and examples	Review techniques used to determine requirements and specifications
	Provide URLs, textbook references, or other sources for examples
	Use sample problem scenario to identify system requirements and specifications
Student practice	Provide document template for identifying system requirements and specifications
	Students identify requirements, specifications in problem
	Each student uploads to the group's allotted area within the LMS the student's completed sample problem document template
	Phase group project manager provides comments to individual group members on the group member's submission, prepares a final summary of the requirements and specifications, and submits it to the appropriate LMS drop box
Feedback	Instructor uses rubric to assess material and provides group text and audio feedback; if necessary, instructor initiates meeting with entire group or approves group to begin identifying requirements and specifications for the semester project

e. *When* (hour, day, week, month) does the problem, opportunity, or directive peak?

Use a table format to summarize your responses. Place the question (who, what, why, etc.) in the first column and the responses to the questions in the second column. Each question may have multiple responses.

2. Complete a table like the one described above by answering the same type of questions above the semester problem presented our business client.
3. Prepare for both the case study and the semester problem:
   a. Additional questions and identify types of documents, files, databases, or other materials that may prove useful to better understand the opportunity or directive.
   b. Sample questionnaires, interview questions and strategies, and sampling techniques that could be used.
   c. Three potential solutions for the given opportunity or directive and conduct a cost benefit analysis for each solution. Submit as part of our group's written summary.
   d. A final written summary of this phase using the Phase I template located in the LMS as a guide.

Phase I Week 3 Advanced Organizer - Course Map

Assume that this semester long course is divided into four equal quarters or periods. Table 3 indicates the iterative, overlapping nature of the system development process. The cell under Q1 or Quarter 1 column filled with ****** indicates where the tasks associated with the requirements and specification phase are in relation to the course and the entire system development process.

Phase I Week 3 Advanced Organizer – Assessment Rubric

Understanding the Problem Domain

3. The author provides a clear understanding of the current system as well as the problem, opportunity, or directive that drives the development of the new system. The user requirements are succinctly defined.
2. The author provides a limited view of the current system and/or the problem, opportunity, or directive that drives the development of the new system. Some user requirements are not included.
1. The author provides very little vision of the current system and/or the problem, opportunity, or directive that drives the development of the new system. Many user requirements are missing.

Fact-Gathering Tools

3. The interview questions and questionnaire or observation form demonstrate substantial thought and understanding of what information is vital for system development. Because of its design, the questionnaire or observation form is easy to follow and use.
2. The interview questions and questionnaire or observation form demonstrate some thought and understanding of what information is important to system development. Use of the questionnaire or observation form may be impeded by its limited scope.
1. The interview questions and questionnaire or observation form indicate the author does not know what information is important to system development.

Clarity of the Alternate and Proposed Solutions

3. Creative and innovative solutions are noted. Alternative and proposed solutions demonstrate an in-depth understanding and perspective of the problem. The proposed solution addresses the issues detailed in the problem statement and user requirements.
2. Alternative and proposed solutions demonstrate an understanding of the problem. The proposed solution addresses some of the issues detailed in the problem statement and user requirements.
1. The alternative and proposed solutions demonstrate little if any understanding of the problem. The proposed solution addresses few or none of the issues detailed in the problem statement and user requirements.

Feasibility Studies

3. The authors demonstrate a clear understanding of the terms technical, operational, and economic feasibility as they apply to their project. The costs and benefits of the proposed system are well developed, thought out, and detailed. Using the costs and benefits as a foundation, the break even analysis, return on investment, and net present value calculations are realistic. Charts that are easy to read and convey a message are used to summarize important points.
2. The authors show some understanding of the terms technical, operational, and economic

Table 3.

Phase	Q 1	Q2	Q3	Q4
Requirements and Specifications	******			
Design and Modeling				
Implement Prototype, Testing				

feasibility as they apply to their project. The costs and benefits of the proposed system should contain more detail. As a result, the break even analysis, return on investment, and net present value calculations could be more realistic. Charts are used to summarize important points.

1. Little if any understanding of the terms technical, operational, and economic feasibility as they apply to their project is noted. The costs and benefits of the proposed system are weak resulting in poor break even analysis, return on investment, and net present value calculations. Charts are difficult to follow.

Organization

3. The order, structure, and overall presentation of the written final summary of the phase are compelling and move the user through section by section.
2. The organizational structure is strong enough to move the reader through the work with undo confusion.
1. The writer lacks a clear sense of direction. The sections seem unrelated.

Mechanics/Conventions

3. The same format (i.e., font, margins, headings, etc.) are used consistently throughout the final summary document. The headings and subheadings are meaningful and provide solid visual clues to the reader as to the content following them. Text is free of misspellings and/or grammatical errors.
2. The format (i.e., font, margins, headings, etc.) is somewhat the same throughout the document. Most of the subheadings are meaningful and provide visual clues to the reader as to the content following them. Text has less than three misspellings and/or grammatical errors.
1. The format (i.e., font, margins, headings, etc.) is not the same throughout the document. Most of the subheadings provide little if any visual clues to the reader as to the content following them. Text has numerous misspellings and/or grammatical errors.

Scoring:
Advanced = 17-18 Proficient = 16-14 Basic = 13-12
Minimal = 11-9 Poor = 8 or less

Phase I Week 3 Instruction and Examples - Development of Effective System Requirements and Specifications

Examples that demonstrate effective use of system analysis and design techniques can be found in many trade and business publications as well as newspapers. Often such publications are available online or through individual college or university library database providers. The most effective examples are often ones that students can relate to and/or have experience with. The redesign of United Parcel Service (UPS) to include more technology as an approach for expanding the efficiency the package delivery system is appealing because the students' experiences with delivery services and varied uses of technology (Dade, 2006).

Phase I Week 3 Student Practice - Case Study for Student Practice

Examples selected for student practice are often projects that have not followed several overriding principles of the systems analysis and design process. The Denver International Airport (DIA) baggage transport system fiasco is a classic case study that illustrates every aspect of what can go wrong and what happens as a result. It is interesting to observe students as they discern how effective analysis and design tend to encourage the development of effective and efficient systems. An online search will generate numerous reviews of the DIA baggage system blues.

COURSE OUTCOMES

While individual and group submissions, presentations, and traditional testing are used by the instructor to assess student learning throughout the semester, the course itself is assessed each semester by participating students and the authentic client. Three weeks prior to the end of the semester, students anonymously complete an institutional course assessment form that is composed of 15 Liker-type questions that seek to provide general course and instructor evaluations and four general, opened-ended questions related to the course. The same type of assessment form has been used by this instructor with both the traditional and hybrid SAD classes for the past 8 years. Although no significant difference is noted on the responses to the Liker-type questions by the traditional and hybrid classes, the responses to the opened-ended questions by the hybrid classes were most insightful.

Student Responses

Anonymous comments have been solicited from students enrolled in this hybrid course for the past 3 years. The feedback has captured the essence of team work and individual responsibility, strengths and weaknesses of the hybrid course design, and use of authentic client and project. Some of the more salient responses include:

Team work and individual responsibility

- *"In other courses you are always told what to do. Here you have to be focused and take personal responsibility for getting the job done."*
- *"Although I realize being able to work as part of a team is important, the move to a team project work was very difficult for me. Up to this time, every computer science instructor preached and published a code of ethics that included a thou shall not share your work, code, or anything with anybody. It's just the opposite here."*
- *"This was the first time I worked on team project in college. My team members worked well together. I liked the rotation of each team member having a chance to take on the role of project manager for several weeks during the course."*

Strengths and weaknesses of the hybrid course design

- *"The course appeared organized because all materials were available online 24/7. The examples from other projects were very useful. Because of the up-front grading rubrics, there were no issues as to how me or my team would be graded."*
- *"At first, the idea of online work to replace class time bothered me. As the course moved forward, I began to really get into it. I realized what the instructor was doing, freeing up more of her time so she could help us with our work online and in person."*

Use of authentic client and project

- *"I'm very impressed with the time commitment and effort put forth by client. He made the course more meaningful and gave insights that I don't think our instructor could have provided."*
- *"This was the most challenging course I have taken and I am a senior! I worked hard but learned more than in any other class in the program."*

Client Responses

From the first time this course was offered utilizing an authentic client and project to the present, there has been no shortage of volunteers to assume the role of client. This involvement provides a win-win situation for the client, students, and institution. Participant provides a mechanism for businesses and institutions to establish and cultivate relationships that support internships, employment, and scholarships. It offers an opportunity for businesses and

their employees to give back to the community and provide students and departments with a window to cutting edge ideas, trends, and technologies. Selected comments from clients are listed below.

Strengths and weaknesses of the hybrid course design

- *"Over time, the problems I present to the class have become more sophisticated and therefore require more detailed and intricate solutions. Otherwise the students have solutions in a matter of days instead of weeks. I attribute this to the additional time the instructor spends working with the students."*
- *"The experience brought back memories of my own college days. Using the LMS was very easy and it allowed me to keep in close contact with students."*
- *"I liked to see the improvements in the project each time a milestone required work submitted. The online discussions keep students on track. You could easily see from their responses how the solutions were derived."*
- *"As first I was a bit hesitant about serving as client. Once I became familiar with the LMS, my time commitment averaged two hours/week. Our organization has benefited greatly form this experience because it allowed to observe students and help identify those that, upon graduation, would be solid contributors to our organization."*

CONCLUSION

The process of developing a problem-based hybrid course is time intensive and requires an intricate understanding of the subject matter, team building dynamics, and learning. Learning the structure of an LMS, developing and revising materials, encouraging student in interactions both online and face-to-face, maintaining online threaded discussions, and establishing and building relationships with authentic clients, can initially seem overwhelming.

It is realistic to begin building a hybrid course by developing and assessing a limited amount of online material at any given time. Once developed, these materials can be reused in subsequent courses. A LMS tool greatly enhances the opportunity to implement online modules and the authentic client/project model. This virtual environment allows frequent, fluid interchange ideas and thoughts between the client, students, and faculty that would be difficult to develop without such support.

Both the student and client levels of satisfaction identified through use of a course assessment instrument indicate that this type of course creates a unique environment for active, project-based learning. The student feedback obtained from this course parallel that of Woodworth and Applin (2007), whose hybrid introductory computers and information course engaged students in team-based problem solving activities using application software. Although there has been much written about the pros and cons of e-learning in computing, Zhang, Zhao, Zhou, and Nunamaker (2004) concisely summarize its merits in this way: "In an e-learning environment that emphasizes learner-centered activity and interactivity, remote learners can outperform traditional classroom students."

REFERENCES

Brown, J., & Dobie, G. (1999). Supporting and evaluating team dynamics in group projects. *Proceedings of 30th SIGCSE Technical Symposium on Computer Science Education, 31*(1), 281-285.

Calongne, C. (2002). Promoting team interaction in the online classroom. *Journal for Computing Sciences in Colleges, 18*(1), 218-227.

Chinn, D., & Martin, K. (2005). Collaborative, problem-based learning in compute science. *Journal of Computing Sciences in Colleges, 21*(1), 239-245.

Dade, C. (2006, July, 24). Moving ahead: How UPS went from low-tech to an IT power-and where it is headed next. *The Wall Street Journal,* p. R4

Edens, K. M. (2000). Preparing problem solvers for the 21st century through problem-based learning. *College Teaching, 48*(2), 55-61.

Gibson, P. J., & O'Kelley, J. (2005). Software engineering as a model of understanding for learning and problem solving. In *Proceedings of the 2005 Workshop on Computing Education Research* (pp. 87-97).

Hazzan, O. (2003). Cognitive and social aspects of software engineering: A course framework. In *Proceedings of the 8th Annual Conference on Innovation and Technology in Computer Science Education* (pp. 3-6).

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research.* Edina, MN: Interaction Book Company.

Jones, C. G. (2007). Bringing the systems analysis and design course into the 21st century: A case study in implementing modern software engineering principles. In *Proceeding of the IEEE 29th International Conference on Software Engineering (ICSE'07)* (pp. 744-747).

Ko, S., & Rossen, S. (2004). *Teaching online: A practical guide (2nd ed.).* Boston: Houghton Mifflin Company.

Mehrens, W., & Lehmann, I. (1984). *Measurement and evaluation in education and psychology.* New York: Holt, Rinehart and Winston.

Polack-Wahl, J. (1999). Incorporating the client's role in a software engineering course. In *Proceedings of 30th SIGCSE Technical Symposium on Computer Science Education* (Vol. 31, pp. 73-77).

Polack-Wahl, J. (2001). Enhancing group projects in software engineering. *Journal of Computing Sciences in Colleges, 16*(4), 111-121.

Rosbottom, J., & Crelling, J. (2000). A generic model for on-line learning. *ACM SIGCSE Bulletin, 32*(3), 108-111.

Sheard, J. (2004). Electronic learning communities: Strategies for establishment and management. *ACM SIGCSE Bulletin, 36*(3), 37-41.

Smith, P., & Tillman, R. (1999). *Instructional design.* New York: John Wiley and Sons.

Woodworth, P., & Applin, A. (2007). A hybrid structure of the introductory computers and information technology course. *Journal of Computing Sciences in Colleges, 22*(3), 136-144.

Zhang, D., Zhao, L. J., Zhou, L., & Nunamaker, J., Jr. (2004). Can e-learning replace classroom learning? *Communications of the ACM, 47*(5), 75-79.

KEY TERMS

Active Learning: Encourages student participation in knowledge construction through reading, writing, discussing, and engagement in higher-order thinking tasks like analysis, synthesis, and evaluation.

Depth of Processing: A theory that posits that learners will recall information better if they learn it in a way that enables them to draw understandings from material studied, not just a superficial understanding gained through memorization.

Hybrid Course: A course with both an online and traditional face-to-face component.

Instructional Designer: A specialist that has extensive experience in learning theory, communication theory, psychology, and pedagogy and uses expertise to design and develop learning materials.

Learning Management System: A software package that enables the management and delivery of online content to learners. Most LMSs are Web-based to facilitate "anytime, any place, any pace" access to learning content and administration. Examples include WebCt, BlackBoard, and Desire 2 Learn.

Rubric: A guide used to score performance assessments in a reliable, fair, and valid manner and is generally composed of dimensions for judging student performance, a scale for rating performances on each dimension, and standards of excellence for specified performance levels.

Virtual, Authentic Client: This phrase refers to an alumnus, advisory board member, or other interested business partners who provides students with a real-life problem that requires the development of a prototypic software product. The client actively participates and interacts with students via the LMS throughout the semester.