

CSS IMPACT

Case Studies of Problem-Based Case Learning Experiences

In recent years Middle Tennessee, like many other areas of the country, has seen the decline and now the initial return of IT-related jobs and careers. According to the Nashville Technology Council (NTC), Nashville has experienced 90% growth in advertised IT jobs since February 2004. However, the returning jobs and careers are different from the ones that were lost due to the global sourcing of IT jobs and the convergence and embedding of technologies. Employers are searching for workers with high-level analytical and critical thinking skills who can adapt with rapid changes in technology and its applications.

The Center for Information Technology Education (CITE) at Nashville State Technical Community College (NSCC) has focused on some of the key aspects of reform needed to create the kind of workforce that employers are seeking - workers that possess both breadth and depth of knowledge. CITE has built on the results of two previous NSF/ATE project grants at NSCC related to problem-based



case learning: the SEATEC Project and the Case Files Project. Through its Corporate Scholars Solutions (CSS) program, CITE has explored the benefits and challenges of using real-world, real-time problems as the basis for problem based case learning. CITE's Corporate Scholars Solution (CSS) program teams business and industry with faculty and students, providing students with authentic problems to solve that require the same skills and knowledge

they will need in the 21st Century workplace.

Researchers have concluded that problem-based case learning, open-ended problems that arise from an actual business situation, produce powerful learning outcomes for students. The CSS program builds upon current research and the proven effectiveness of problem-based case learning, providing a win/win/win situation for students, faculty, and business.

Institutional and Programmatic Impact



Four institutions - two community colleges and two universities - were principal participants in the Corporate Scholars Solutions (CSS) program, CITE's emphasis on contextual learning and the use of problem-based cases. The CSS program was piloted in Spring 2003 and ran through Spring 2005. During this time, 24 CSS projects were conducted with the involvement of 19 employers and 333 students.

In Fall 2005, interviews were conducted with faculty members who used problem-based cases in their courses at the community colleges and universities. The instructors were asked to reflect on what happened in the class and what impact the experience had on the course, as well as teaching and learning for both the instructor and students. Following the interviews with individual faculty members, interviews were conducted with administrators at the partner institutions in regard to the impact of the CSS projects on their programs.

A New CIS Curriculum

A positive outcome at one institution has been a new CIS curriculum designed around a technical core for different concentrations. The department has added new courses

directed at helping students understand their role in the business context. "This is a significant change," said the Dean, who also noted that this change did not occur without growing pains.

During the preliminary stages of the project, there was a high level of faculty involvement. Several faculty members worked on the planning grant. They attended a weekend retreat and worked with CITE and the Chamber of Commerce to prepare the grant proposal. When the faculty began working under the grant, they attended informational sessions during in-service. "We asked for volunteers to incorporate CSS projects in their classes," the Dean related. "There was not as much enthusiasm as we had hoped." Faculty members were required to attend a 3-day workshop designed to get faculty involved. All who were asked to use CSS projects cooperated, but they didn't take the initiative that was expected.

In retrospect, the Dean believes that faculty should have been better informed and more involved. After the planning workshop, they were enthusiastic. It was more a curriculum development focus; they were told what to do. But they never caught the vision for what could really happen and how the program could really turn around.

The hardest thing for the instructors, according to the Dean, was how to make adjustments when a business situation was brought to them. "They know how to use hypothetical business situations in their classes, but we did not spend enough time helping them to know how to frame the problems for their classes," he said. "We didn't build on their prior knowledge. This has been an important lesson learned."

The impact of the CSS experience has been positive for this program, though, in the Dean's words, "not what it could have been." On the whole, faculty members know that the curriculum is out of date. They realize that the business environment is changing, that business and industry today want employees who are not just well-grounded in the technical concepts and have a background to learn new programs, but are also well-equipped to put that knowledge to work. The instructors have spent time in the business world, so using project-based teaching was not new to them. "They did not have to start at zero," the Dean pointed out. "No one took it far enough, but we have made progress." Faculty has moved toward more student involvement, bringing more active learning strategies into the classes. Especially in the introductory classes, instructors have embraced many of the concepts that were presented.

In regard to plans for the program, the Dean stated that while some of the instructors in standard courses still do not recognize the importance of the Learning Cycle, the good news is that as they develop new courses, they are building problem-based case learning into the classes. New classes have been designed

around the National Skills Standards. A business focus group helped adapt the standards to local needs.

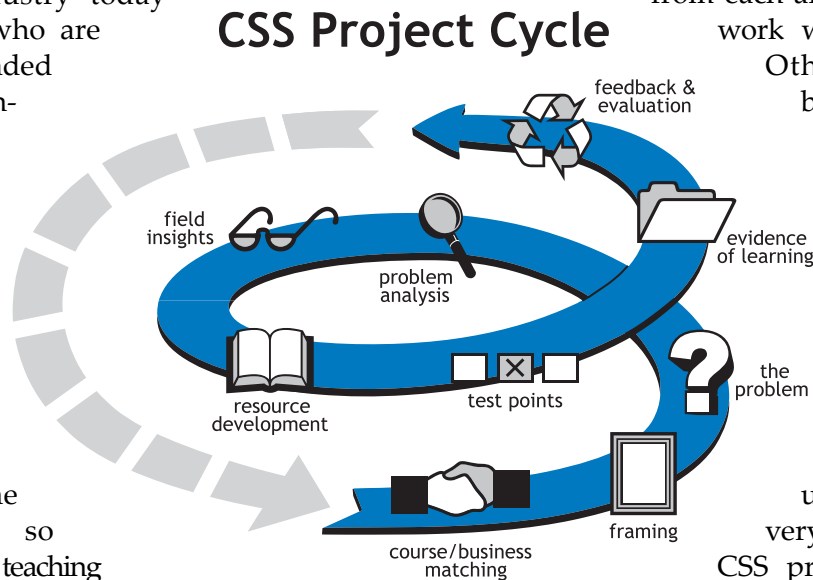
Baby Steps - A Good Start

The Dean at another of the pilot institutions described their progress by saying, "We have taken baby steps, but it's a good start."

The Dean initiated the process after serving on an oversight committee. He went to his Computer Science and Geographic Information Systems (GIS) faculty and asked for volunteers. One faculty member from each area volunteered to work with CSS projects. Other faculty members attended training sessions, which the Dean thought were very useful, but to date only two instructors have used CSS in their classes. The classes that used CSS were very successful. The CSS projects were most applicable, the Dean believed, in "second-level" classes where students had the basic skills. The introductory classes did not work as well, he believed, but overall the experience was positive and has been good for the program - because active learning is a proven concept.

The instructors that tried CSS projects are still using problem-based case learning in their classes. They have shared their successes internally, and other faculty members are interested.

"This is a painfully slow process," said the Dean. He expects other faculty to take the leap. "There is the element of fear - they don't



have as much control," he says. He has been working with the business faculty, sharing some of the ideas from problem-based cases, and some of those instructors are looking for a business situation to use in their classes.

The Dean thinks CITE was very valuable in offering instructor training. He would like to see continued sharing of success stories. "Nothing is better than sharing with each other," he said. The fact that instructors were offered release time to work on CSS helped because it takes a tremendous amount of time to redesign a course to incorporate problem-based cases.

A lesson learned from the experience was that goals must be realistic. The Dean admits that he likes things to happen quickly, but it just takes time for faculty to be comfortable with change.

A Move Toward "Real World" Experiences

At another institution, the initial motivation for CSS came from the President who was serving on the National Visiting Committee. The type of technical education promoted by CSS was in line with the institution's vision statement that articulated the kind of education they wanted to see at their institution. The President encouraged the faculty to become involved in CSS projects. The faculty attended workshops and the Synergy Conference and were interested, but the Department Chair was the only one who actually followed through.

According to the Department Chair, there has been some movement toward more "real world" experiences. The whole idea of the CSS projects fits into the Department Chair's philosophy of teaching, and he is not discouraged by the fact that he is the only one who has embraced problem-based case learning in his classes. He doesn't believe that other instruc-



tors are really opposed to the idea. It just takes time for faculty to change, and there is a fear of change. Instructors need to see that something new is working well. They know that in order to implement problem-based case learning in their classes, they will have to make time within the course and they have to take time to plan for it. They have their courses designed and they don't want to give up something unless they believe they will get something from it.

Another positive outcome has been that the CSS projects have given business and industry in the area a sense of what is happening in their program. It has strengthened their connection with business. Out of this connection have come several internships - their students placed in businesses.

The CSS objectives fit well with the university's vision statement that calls for learning to be integrative and collaborative, to prepare students with the knowledge, skills, and

habits of mind to live productively in a global society. The Department Chair has used three CSS projects, and he is hopeful that other faculty will become involved so that CSS will become a part of their program, helping them to reach their institutional goals. He'd like to see his institution commit to a greater degree to this type of teaching, or to create its own version based on the approach. He will call upon CITE when they know where they are going with this.

CSS Supports Initiatives

For another pilot institution, the initiatives adopted as a result of a Tennessee Board of Regents Academic Audit included a call for projects that link the college with business and industry. CSS projects provided opportunities for faculty members to interact with area business and industry representatives with whom they would not have engaged otherwise. Professional development opportunities enabled faculty associated with CSS to meet and learn with faculty from other pilot institutions.

Common Themes

The interviews with administrators in the pilot institutions produced a number of common themes related to the impact of problem-based case learning on their programs. They recognized that some classes were more successful than others in the use of problem-based cases. Following are indicators or "ingredients" for success that were present in classes where the most positive impact was noted:

- Faculty "bought in" to CSS; they chose to be part of the pilot program
- Faculty members felt they were well prepared and therefore secure in letting go of more traditional roles and structures of teaching and learning.
- Faculty "got it" in terms of framing the problem and using it as a vehicle for learning; the



case was not viewed as an "add-on."

- There was a recognizable intersection between the knowledge and skills found in the business context and the anticipated course outcomes.
- The business partner's expectations and the instructor's expectations were "in sync," due to a shared vision of education and the 21st century IT professional

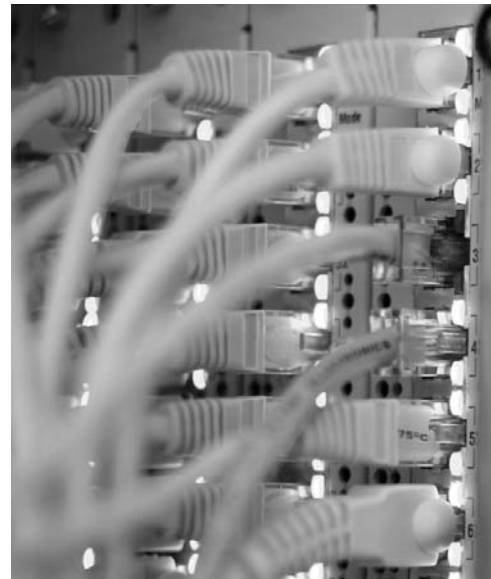
In all four pilot colleges and institutions, problem-based case methods will be included in future plans for their IT programs.

Recognizing "A Perfect Fit"

Background Information:

Course Description: Applied Networking is a four-hour capstone course at a community college. Developed by the instructor and based on his own experiences in the workplace, this is a hands-on course in which the students learn network management concepts. The instructor provides 12-15 situations designed to teach students to build and connect networks, install software to run applications, and use troubleshooting tools and strategies. Prerequisites: Basic knowledge of client/server installation methods, assigning rights, permissions, security settings for disparate systems, fundamental use of network management tools, designing and implementing lans, mans, and wans.

Situation: The business situation came from a medium-sized church with various networking needs. The church had outdated equipment that needed to be replaced, but they had no money for that purpose. In addition, they needed to work out a method for sharing computer data that pertained to the congregation without interfering with the sensitive information from the database, and they wanted to network their computers.



Learning Experience:

The youth minister and one of the two administrative assistants visited the class and discussed the church's networking needs. Although the students were not able to visit the site, the instructor had made a site visit and had photographed the computers, cabling, operating systems, and peripherals. Students had access to the photos and were able to begin analyzing the problem based on the meeting with the staff members and the photographs. The students were divided into four teams and challenged to determine what services might be provided to the church under the restraints imposed.

The class worked enthusiastically from the beginning. The instructor attributed students' enthusiasm to the fact that this was a real-world problem and the students were able to talk with the business partner. Another motivating factor was the possibility that their solution might actually be implemented. Communication with the business partner throughout the case was a positive experience for the students. Students took initiative, worked outside of class, and exchanged many e-mails with the instructor as they came up with questions in the course of their research.

The four student teams all gave very good presentations of problem solutions and recommendations for improving the church's communications network. The instructor pointed

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out the wide variety of solutions. Some did not take into account the fact that the church had no money for computer upgrades. One team went above and beyond to find a solution that dealt with the financial issues as well as the computer issues.

Results:

Impact on Students: Through working the case, students gained knowledge in networking concepts such as sharing of data, security systems, virus protections, and firewalls. They gained troubleshooting skills and learned how to research many different areas. In addition to learning the technical content, students gained presentation skills and learned valuable lessons about interpersonal relations. They encountered multiple perspectives when they encountered the situation in which the two administrative assistants disagreed over protocol.

Students from this course were better prepared for the workplace than students in traditional courses, the instructor stated. He reiterated that the Applied Networking course is a "hands-on" course in which students always work on cases, but this case was very valuable because students had to "go into the world and find the answer, where there's no answer in the book."

Impact on Teaching: The instructor reported that this experience has not changed how he teaches. He has always felt strongly about using a hands-on approach and real-world cases, but his cases were historical cases. He will look for other cases - "the right situation." He will continue to use scenarios in his class but he has tried to develop new ones that fit as perfectly with his class as the church's situation fit.

Impact on Course and Curriculum: The "real world" problem, not one that was just created for the course, was a benefit, but the instructor did not note an impact on the curriculum.

Lessons Learned: The situation was referred to as a "good match" or "perfect fit" for this course. The students were able to master the many of the KSAs for Applied Networking - such as troubleshooting in a small business setting, analyzing networking problems, and using research strategies to find solutions - by working through this business problem. The instructor attributed the success of the experience to the fact that it meshed so well with the objectives of the course. "New installs, testing cables, all the techniques that we teach in our courses - it was really good for what we do." Not all cases fit all classes, the instructor pointed out. "You can't force it."

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Producing a Better Programmer

Background Information:

Course Description: In a four-hour JAVA Applications class at a community college, students learn basic programming and coding in the JAVA language. Topics include JAVA compilers and interpreters, application development concepts, class methods, inheritance, objects, events, error handling, applets, servlets, database manipulation, and other concepts related to developing JAVA applications. Prerequisites: C Language Programming.

Situation: A company that owns five sub shops wanted to develop an integrated computer system to replace paper for their accounting. The company started out with one store and a "do-by-hand" payroll system. As the number of stores grew, the payroll system was never updated. The major problem in the current system was the manual processing and documentation of the employee time schedule. The majority of the employees are in high school, and frequent changes in schedule pose difficulties when each manager on each shift must fill out a shift report and fax it to accounting. Also, the owners expressed their concern in the case of overwhelming storage issues, legal considerations, the possibilities of natural disaster, and other uncontrollable factors. The owner wanted to address the amount of paper that was being printed and faxed between stores, the amount of hand calculations that went into each payroll, and the "shift report problem."



Learning Experience:

The business partner came to class and explained the company's needs, showing examples of reports. Students were able to ask questions. They were excited about the situation because it was a "real world" problem. They were required to use the Systems Development Learning Cycle (SDLC), which was not part of the JAVA class objectives. The instructor "spent the time not teaching JAVA but working on the case" - but in the end the business problem became a means by which they learned the JAVA syntax.

Results:

Impact on Students: The instructor commented that the experience with this business problem did not make much difference in how well the students learned Java, but "it did produce a better programmer." In the traditional Java class, students do not experience teamwork or make presentations. The skills students gained by working in teams and presenting their solutions are valuable workplace skills.

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Impact on Teaching: This business problem is one of several that this particular instructor has used in his classes. He has had difficulty finding business problems that "match" with his courses but wants to use the ideas from problem-based case learning if he can get the "right" situations.

Impact on Course and Curriculum: The instructor has included a team project in the course. He would like to get another authentic business problem for the Java class.

Lessons Learned: "I could have presented the problem the first day," the instructor said. He waited until half way through the course to introduce the business problem because he believed students needed some basic skills in order to work through the problem. In reality, working through the problem is a way for students to learn the Java syntax.

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Before the business partner introduced the situation to the class, the instructor had researched the problem himself and had knowledge of where students could find answers, so he knew how to steer them in the right direction. He pointed out that even though a problem is open-ended, the instructor needs to stay ahead of the students, and that takes a lot of time and effort.

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Balancing Content with Competencies Added

Background Information:

Course Description: In an entry level programming course at a community college, students use the C programming language to learn program structure and design. Strong emphasis is placed on using good programming practices and adhering to programming standards. Students are in their first programming course and, generally, have only had a prerequisite general computing course (Word and Excel).

Situation: The business partner, from a Department of Energy (DOE) facility, presented the requirement to develop software to control the movement of machines used to measure the accuracy of the production of nuclear weapons components. The business partner provided detailed design specifications that could be incrementally decomposed and implemented as the class learned the skills required for a particular code segment.



Learning Experience:

The business partner, the faculty and the students worked as a team to address the problem. Following guidelines developed by CITE, the learning cycle helped focus the learning on process skills as well as needed content knowledge. Specifications were given via complex math equations which represented the range of motions required for testing. Pseudocode defined the program necessary to satisfy the requirements. The code segment needed for this problem was well suited to the competencies required of the class.

From the beginning, the students were motivated - even the students that the instructor considered "poor" students. They worked in teams of three. Keeping the problem open ended as to solutions motivated authentic communication with the business partner, promoted consideration of multiple alternative solutions, and provided an authentic context for efforts after solutions. Even though security issues prevented a site visit for the students, the business partner provided a valuable experience for the class and allowed the class to experience what it feels like to be a professional programmer working in a real-world setting.

The faculty acted in a project manager role rather than the traditional instructor role. Instructor responsibilities included scheduling several status review meetings to keep the teams on track, developing exercises on the fly to help the programming teams understand segments of the overall problem implementation process, and providing guidelines for developing project plans and for creating and delivering presentations.

Results:

Impact on Students: Students learned that it's not "cheating" to collaborate - not that they should share code, but rather share the process they find.

Students learned that it's not "cheating" to collaborate

Students reported that the CSS project was a "value added" experience. They felt they gained a real-world experience not usually available in the classroom. Their final presentations to the business partner and a faculty audience revealed professional communication skills. A distribution of skills was noted; those not good at speaking assumed other roles for the presentations. They improved their writing skills.

Their solutions actually produced alternative solutions for the business partner. Even though the problem had already been solved, the students' solutions added a different language, a dimension his solution did not have. The new language affords interface with other systems.

Impact on Teaching: The instructor said, "My fear was taking away from the syllabus. As it turned out, students stepped up to the challenge." He stated that he had always taught through application; all problems must have a root in application. However, the CSS project has made him more sensitive to the practical aspects of the problem, the application issues. He tries harder to tailor the course to meet competencies.

Impact on Course and Curriculum: Some content was not covered, but other competencies were added. It is important to be conscious of standards, the instructor noted, but, in his words, "a problem based approach will add other, maybe more valuable, skills. It is a constant balance."

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Lessons Learned: The instructor stated that using a CSS project with an introductory class proved to be difficult. Even though the instructor may be using a problem-based approach, the steps to formalize, making connections to an outside source, is difficult.

The instructor also pointed out that unless this kind of effort is funded, it won't work. He pointed to the five courses per semester that community college faculty are required to teach and the lack of time for anything extra. The biggest challenge for two-year level programs is compensation for keeping a client involved, according to the instructor; however, he emphasized that time is really a bigger factor than money.

From the instructor's point of view, managing the project requires an understanding of the big picture (real world context and scope of the problem), giving implications for scaffolding, breaking the problem into manageable segments and/or focusing on achieving a piece of a larger solution.

The situation itself was highly technical and complex, but the instructor extracted from it what could be used with his class. He took a high-level situation and framed the problem for an entry level class.

Learning "Things We Didn't Know We Would Learn"

Background Information:

Course Description: A Systems Analysis and Design class at a community college is a four-hour course in which students use the first three steps of the Systems Development Life Cycle (SDLC) to learn how to handle systems problems. The cycle takes them through (1) analyzing the nature of the problem, (2) determining how the current system works, and (3) designing a new system. Prerequisites: Two microcomputer programming courses.

Situation: A company that provides tutoring, testing, and consultation services brought the business problem to the class. The company, employing many tutors and serving many students, wanted to integrate all of their data systems, allowing for the accurate and efficient sharing of information with the accounting firm that provides their payroll and billing services.



Learning Experience:

A representative from the tutoring company met with the class and presented an overview of the company and its services. He explained the data systems currently in use by both the tutoring company and the accounting firm and discussed why the present systems increased personnel time and created the opportunity for human error. The students were divided into teams and challenged to assess the situation and make a proposal for the seamless transfer of data between the two companies.

Students were excited about working on a "real world" problem. They remained enthusiastic until they reached a point at which they were unable to obtain the information they needed from the business partner. Several requests were denied. Though the process was frustrating for the students, they were able to gather information by going on-line. Working from the information they had, each team did research on possible solutions and presented a set of recommendations to the business partner. Presentations included costs, benefits, and contact information for the software solutions they recommended. The instructor guided students through the difficult process, pointing out that the ambiguity they encountered was typical in the "real world." In the end, the recommendations they presented were received favorably by the business partner.

Results:

Impact on Students: Students learned to use the SDLC to evaluate systems and recommend solutions. They analyzed both hardware and software in two separate companies and designed a solution to allow for the efficient sharing of data between the tutoring company and its accounting firm. They learned that the first two steps of the SDLC - analyzing the problem and the current system - must be given adequate time before rushing into the third step.

The instructor stated that the class "learned things we didn't know we would learn." When the business partner refused to provide critical pieces of information such as screen shots and file layouts because of confidentiality issues that he was unwilling to work through, the students took the initiative to get information from other sources and did an excellent job improvising. The experience resulted in a valuable "real world" lesson in problem solving.

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Students learned to appreciate the complexity of taking into account various viewpoints and details necessary to complete an open-ended process.

Students from this course were better prepared for the workplace than students in traditional courses, the instructor stated. The real benefit, according to the instructor, came from working in teams and making presentations - the "soft skills." They gained insight into the group decision-making process and learned negotiation within a project team.

Impact on Teaching: Even though the "real problem" in this instance was successful, the instructor did not believe that an authentic business partner was absolutely necessary to have a PBCS experience in the class. He would like to develop more cases and believed that he could give the students hypothetical situations which would result in similar outcomes. He noted that he was never comfortable using the tools provided for scaffolding learning.

Impact on Course and Curriculum: The instructor cited examples of miscommunication within the department and problems dealing with organization and personalities as reasons he believed the PBCS approach did not make a significant impact on the course and curriculum. He reported that the faculty had always used cases, and they will still use cases, but he did not expect the curriculum to change significantly.

Lessons Learned: Problems occurred because the business partner did not provide adequate information. The owner of the company and the representative who actually worked with the class had different perspectives about how much information they could or would actually provide the class. A lesson learned from this experience was to make sure that the business partner's needs are well defined from the beginning.

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Promoting Professionalism

Background Information:

Course Description: A Systems Analysis and Design course at a university deals with the computerizing of new and existing business systems. Juniors and seniors take the course. Topics include analysis of systems, design of computerized systems, design of screen layouts, report formats, and input documents, programming of a system as a member of a programming team, implementation of systems, and documentation of systems. Prerequisite; Knowledge of COBOL.

Situation: The business partner was a manufacturing company that provides indoor comfort systems and comprehensive facility solutions for residential, commercial and industrial building needs. Their computer systems have a Microsoft Windows networking and computing environment. The structure consists of a central NT Domain, where user ID's, file permissions, and daily administrative requests are handled. The computers are on a four year lease program from Dell. When the computers' lease expires the computers are returned and new computers leased. Licenses for computer software are purchased independent of the computer hardware lease making it difficult to manage. The company was audited by Microsoft and told they were not keeping adequate records of their licenses. The business partner wanted the students to find solutions for more efficient record-keeping.



Learning Experience:

Students were assigned this problem as a part of their class. They already had skills in analysis and were accustomed to working in groups. Teams worked to do an analysis of the current system; developed a project history; met with the business partner to gather additional information; visited the plant's offices; and researched possible solutions. Each team presented a unique solution to the business partner. Clearly the solutions had been well thought-out. Two teams offered to design a system to manage and audit the software usage. Three teams recommended commercially available software solutions. Students worked diligently under faculty guidance to go through the design process and one student remarked that being in this class was like a job. It was noted that the CSS project was in fact a job and one the student could list as real world work experience on her resume.

The business partner also highlighted for the students the need to develop team skills and strong communication skills as well as technical skills. He reminded students that outsourcing is making it imperative that IT professionals here have a suite of skills, both analytical and technical, but especially communication and team skills.

Students reported that the CSS project was an extremely valuable experience and their presentations revealed remarkable professional communication and technical analysis skill.

Results:

Impact on Students: Students reported that the CSS project was an extremely valuable experience and their presentations revealed remarkable professional communication and technical analysis skill. Several members of the university's administrative and academic community attended the presentations. Students were dressed professionally; delivered their recommendations with clarity and exceptional analytical facility; and offered viable solutions. The business partner remarked that one of the team's recommendations was the one the company had elected to use. The Director of Extended Education at the university commented on the students' exceptional competence in the areas remarked on by the business partner.

Overall, the teacher reported that the students that came out of this class were better prepared for the workplace, compared to students in more traditional courses.

Impact on Teaching: The instructor has always done project-based approaches but has used "canned projects." He is very positive about using real-world applications and has followed up with two other projects from the same business partner.

The instructor believes students learn a lot from business, and sees that problems in our courses need to expose students to how things are done outside the university.

Time was a factor; he had to "jam things up" to get the course covered, but he believed the project added value to the class.

Impact on Course and Curriculum: Some modifications to the course will be made, but not major changes.

The instructor believes students learn a lot from business, and sees that problems in our courses need to expose students to how things are done outside the university.

Lessons Learned: The instructor stated that he presented the problem to students before the business partner arrived, so they were prepared to ask questions. He laid out ground rules about communicating with the business partner.

The business partner was always excellent when he was able to spend time with the class, but students learn to allow for the business partner to be out of touch sometime because of travel.

The instructor reported that he was fortunate to have the Provost's and President's support to be involved in the business community. This involvement led to the relationship with the business partner. The instructor had known the business partner for a long time, which was a great advantage.

Working Through Frustrations

Background Information:

Course Description: The four-hour Microcomputer Database Programming (Access) course was taught at a community college. In this introductory course, students use Access to learn the concepts and syntax of relational database management and SQL concepts. Prerequisite: Program Logic and Design (Systems).

Situation: A company that locates pizza kiosks in convenience markets contracted with a consultant to track all of their in-house professional development. The consultant - not the business partner - brought the business problem to the Systems class and involved that class in determining what systems the pizza company would need to operate a "training university" for their employees. The Access class objective was to take the system design generated by the Systems class the previous semester and develop the application using relational database. In setting up files for instructors, students, courses, etc., students experienced building a database from scratch and working with SQL syntax.



Learning Experience:

The instructor set the framework for the problem-based case and let the class watch the media pieces. The two scenarios depicted Help Desk employees responding to problems via phone, one knowledgeable and helpful, the other confused and confusing. Some of the instructional resources used were viewed by students as busywork. They did not readily accept the teamwork concept and complained about the work required outside of class. The instructor tried to relate the team experience to requirements in the workplace and relied heavily on experience some students already had with teams in the workplace. She made the CSS project count for a test grade. Some students refused to meet in teams but sent work by email.

The students' problem solutions and recommendations were not as effective as the instructor would have liked, but she reported that students gained skills in making presentations.

Results:

Impact on Students: Students' experience with this case generated frustration, but some positive outcomes were noted. From the experience, which the instructor described as "messier" than the cases that come with the texts, students did learn the value of designing on the front end, not designing as you go. The extra component, compared to the cases previously used in the class, was the requirement that students had to do more design of database initially. The instructor's assessment is that, in regard to subject matter, the students who had this experience are as well - not better - prepared for the workplace, compared to students in traditional courses - but these students may have gained an edge in the soft skills - making presentations and teamwork.

Impact on Teaching: The instructor reported that she has always used real-world cases in her classes. She did not consider her classes traditional. She used the pizza company's business problem instead of the case study she normally used with the class.

She considered some of the instructional resource tools useful and plans to use them again. She also reported that she is using teams more now and spending more time on team-building activities - defining roles of team members and preparing students for the experience.

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Impact on Course and Curriculum: Since the introduction of problem-based case learning in the classes, the department has looked at its curriculum and is making modifications to allow more time in database programming for the design. The instructor expressed her opinion that the CSS cases don't belong in every class. She noted that there was pressure on the department to develop and use problem-based case learning, and that using real problems and real clients are "great as long as you're very careful about whether you're serving the client or the student."

Lessons Learned: The instructor reported that the consultant had been involved in the Systems Design class and helped to set up the plan but was not involved in the Access class. She considered this a significant issue because her students needed clarification and, since she was working from information given and decisions made the previous case, she had questions, too. The Systems class knew what was needed, but that information did not carry over to the Access class. The instructor suggested that the Systems class revise their "Deliverables" if the case was used again in both classes.

A lack of good support materials contributed to some of the frustrations in this class. It was noted that the consultant who worked with the Systems class did not have all the information that the actual business partner, the pizza company, would have been able to provide.

The instructor did not find the scenarios useful in setting the stage for the problem. She noted that because of the scenario, students thought the case was about Help Desk training, and they had a hard time grasping that the case was about training throughout the company. Although she had been involved in developing the scenarios at the D&I Workshop, she pointed to the fact that there was too little time for brainstorming to create what would actually be useful in the classroom. The pressure was on to create a product quickly, and faculty did not have time to "reflect," which is "what we say students should do."

...faculty did not have time to "reflect," which is "what we say students should do."

Experiencing "Win-Win" with Business Partner

Background Information:

Course Description: In a Project Management class at a community college, students learn about the design and development of a GIS (Geographic Information Systems) database, data validation, and spatial analysis. They develop skills in defining project scope, evaluating available resources, and developing a plan for analyzing and scheduling the effort to address the given problem.

Situation: The business problem came from a city government. Prior to 2003, each governmental agency within the city maintained its own separate maps and used different mapping software to create their data. In 2003, the city partnered with other local governmental agencies to move into a GIS environment and standardize on a common base map and software platform that would allow data to be shared throughout city agencies. They chose to participate in the Tennessee Base Mapping Program, which was started as a statewide initiative to provide all counties with a standard base map that would seamlessly integrate with all other counties participating in the same program. The software platform adopted by the State of Tennessee's Base Map program was Environmental Systems Research Institution's GIS software, which uses shape file as its native file format. The city previously used AutoCAD to create zoning maps that represented the 16 unique zones within the city limits.



Learning Experience:

The business partner, the faculty and the students worked as a team to address the problem. They developed a procedure for creating shape files for the zones that would be fitted to the new land base backgrounds purchased from the State Base mapping system.

Following guidelines developed by CITE, the faculty instructor acted as a project manager and a resource for the student team. A number of issues were identified and decisions were made based on software capabilities. A separate shape file was created for each of the sixteen land use zones.

Results:

Impact on Students: Students reported in their presentation to the business partner a finished solution of 16 separate shape files that were edge-matched to insure they aligned properly with adjacent zone shape files. The presentation was extremely well executed and professional delivery was noted by all in attendance. The business partner commented that this solution had already made his job more efficient and the accuracy of the solution enabled him to respond to zoning questions with greater precision than before. He called it a "win-win situation."

The presentation was extremely well executed and professional delivery was noted

Students stated that they had learned so much from this effort and that any omissions of learning about software features was overridden by the practical, real world experience they had gained. A color map of the zones they had created was included in their presentation and it was noted that such a product would serve them well in their own portfolios as they conducted a job search.

Impact on Teaching: The instructor always used project-based approaches, but with made-up problems. The fact that the CSS project was based on a real business problem was the real value she found in this experience. Working with a real business partner was valuable. She would like to continue to use problem-based case learning if the business problem fits the class. She will be more alert to what the local demand skills are. She has planned two new classes, one based on a land records problem and one based on a utilities problem.

Impact on Course and Curriculum: The instructor noted that the GIS project was perfect for the course objectives.

Lessons Learned: The business partner's participation was significant in the success of the class. He provided direction, guidance, and data. He made arrangements with city officials and police for students to work in the field and accompanied students when they did their field work.

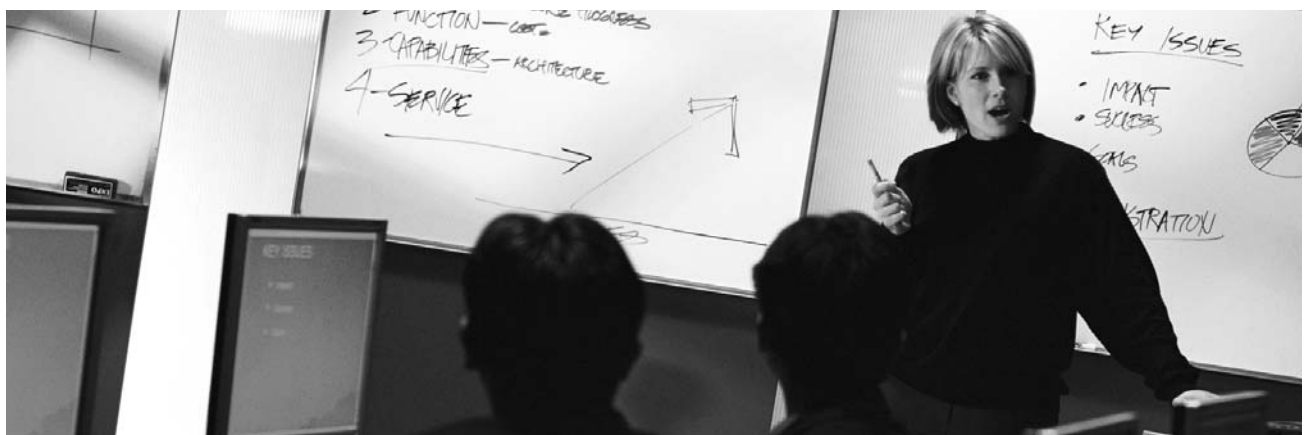
The instructor emphasized the importance of having a business problem that fits the course. She tried using the same business problem in a Database course, but it did not work as well as in the Project Management course.

She also mentioned that she was not forced in any way to use this problem in her class or to try problem-based case learning, but after attending a workshop at her Dean's suggestion, she decided to try it.

The instructor needs to have expertise in the content area in order to trust the student directed process - recognizing multiple pathways to knowledge, skills and application.

For some business partners, a direct benefit may be realized. In this case, the local newspaper noted in an article about this effort that the students' contribution probably saved the city \$25,000.

The instructor emphasized the importance of having a business problem that fits the course. She tried using the same business problem in a Database course, but it did not work as well as in the Project Management course.



Recognizing One Size Doesn't Fit All

Background Information:

Course Description: In a four-hour network security class at a community college, students learn how to protect networks from those who want to infiltrate the system. The course focuses on methods of defense against attacks by viruses or any programs that would deny service or shut down the system. Students study the psyche of the hacker and learn the tools that the hacker uses to infiltrate the system. They learn to download and run the tools that a network administrator can use as defense, such as firewalls and port closings, and learn to use patches and upgrades to keep systems updated. This is a hands-on class where students work attacks on each other's machines. They are required to work a comprehensive case study at the end of the semester. Prerequisite: Some knowledge of networking theory and familiarity with networking equipment.



Situation: The business problem came from a music publishing company with eighty-one file servers that needed upgrades for virus protection and Microsoft updates installed. The scope was not clearly defined in the beginning and continued to be expanded with each conversation, but the instructor saw the situation as a CIS problem because the business partner asked the class to write a special program to address specific requirements.

Learning Experience:

The business partner met with the class to explain the company's needs. The instructor framed the problem so that his students could learn about Network Security. He instructed students to look for methods of automated patch management. They researched products that were available and talked to vendors, with each team taking a different vendor. Then the teams came together and evaluated the products as best they could. They put together recommendations for the best product and sent their report via email.

The instructor pointed out that the experience could have been more productive if the business partner had provided information on how his servers were set up, in order to replicate that environment as they did their evaluations. Another issue, according to the instructor, was that the business partner was perceived as having a strong bias against fair evaluation; he had certain products that he wanted to use, which were not the products that the students recommended as the result of their research.

Results:

Impact on Students: The instructor received many negative comments from students because they had to "stop the learning process to do the case study." They were not as prepared for the workplace as they would have been if they had spent the four weeks working as usual.

Impact on Teaching: The instructor stated that he was a great believer in case studies because "they help students think outside of compartmentalized learning" but the experience with this case did not result in any changes in his methods or tools. He uses role playing, brainstorming, and matrices that he developed.

He indicated that he would use case-based learning if the business problem accurately fit the course.

The instructor stated that he was a great believer in case studies because "they help students think outside of compartmentalized learning"

Impact on Course and Curriculum: The instructor's opinion was that "people were too wrapped up in the mechanics of the program and instruction was secondary." He believed this case had a negative impact on instruction because the problem was not developed to fit the class; it was developed to benefit the business partner.

Lessons Learned: The instructor believed that the case was inappropriate for the Network Security class and that many of the problems encountered were the result of the bad fit. He emphasized the need for more faculty involvement in selecting the business problems for their courses. Some business problems are too complex for two-year college students; they do not have the necessary foundation knowledge. In this case, the business partner wanted students to do programming, audit servers and determine patches, install patches and create reports - activities that were beyond the scope of this class.

The instructor pointed out that the business partner may not have understood the purpose of the case. The students were supposed to use the problem as a learning experience, not simply do free work.

Faculty would benefit from more lead time. The instructor needs time to visit on site with the business partner, to clearly define the problem in his or her own mind, to develop the problem/solution sequence, and to review with the business partner so they are in agreement about the scope.

The sequence for presenting and implementing the problem with the class should relate to the teaching plan of the course. The problem must be narrow in scope so that it applies to the specific area of knowledge being covered in the course in which it is used. The instructor needs time to see that this happens.

A point to consider is that in the "real world," recommendations are not solely based on technical excellence and are often biased by corporate standards and product preferences.

The instructor needs time to visit on site with the business partner, to clearly define the problem in his or her own mind, to develop the problem/solution sequence, and to review with the business partner so they are in agreement about the scope.

Learning Java by Working Business Problem

Background Information:

Course Description: A programming course at a university provides students a practical programming efficiency in writing computer programs using Java programming language. Deep understanding of structural and object-oriented programming is provided with the implementations of Java applications and applets. This is an introductory level course in Java and the prerequisite is C++ programming knowledge. Most of the students are junior-level.

Situation: The Service Parts Operations division of a global automobile company distributes parts to the company's 438 retailers all over the country. They have more than 18,000 parts that dealers can order and more than \$324m annual sales. Regional Parts Consultants (RPCs) act as the main link between the Service Parts Operations division and the company's dealers. The RPCs have been using a database system developed entirely in Microsoft Access. It provides many different user interfaces, with more than twenty tables and many queries. The RPCs use a local database in their computers during the day and then they synchronize their database with the main database located at the headquarters for the Service Parts Operations division. These efforts are slow and tedious, resulting in excessive personnel time required to file and sometimes re-file reports. Issues also include surcharges from hotels/motels for hours of connect time; time and effort to restore databases corrupted in this process; and lost data due to database corruption. The company does not plan to replace this primitive system.



Learning Experience:

The business partner engaged the student teams as extensions of the companies' technical staffs. Students were extremely motivated. They communicated with the business partner through e-mails and conference calls. The first few weeks were spent defining the scope of the project. In the second half of the semester, the problem had to be reshaped because twenty tables were too many, and students could learn what they needed to learn with fewer tables. Going through the CSS learning cycle afforded multiple opportunities for assessment and refinement of the teams' solutions.

Five teams of students competed but also helped each other. Their solutions were all different in some respects. Student teams redesigned the current system by using Java programming language but considered Visual Basic programming language as an alternative solution. Java was preferred since it is platform independent and the system designed can be used in any operating system. It also has a unique database connectivity API (Application Programming Interface) that provides a seamless connectivity to virtually any database. In other words, the solution affords the flexibility of using any database such as Microsoft SQL Server and Oracle. The business partner indicated that one of the team's solutions was being considered by the automobile company for actual implementation.

Results:

Impact on Students: Students did not know Java programming language when they started but learned Java as they worked through the business problem. The instructor observed the quality of the communications (email, telephone conference calls, presentations to the business partner and other faculty) and noted that a professional manner emerged. Students gained an understanding of current business processes and communication techniques. They learned how to work effectively in a collaborative environment and experienced how technical projects are completed in the corporate business world. The business partners stated that the "results of the student teams' efforts were right-on."

Students did not know Java programming language when they started but learned Java as they worked through the business problem

Overall, students learned not only important IT course content but also problem solving, communication, critical thinking, and collaboration skills.

Impact on Teaching: The instructor had a limited idea of what CSS projects in the beginning but was able to use the problem to teach what he wanted to teach. He emphasizes that the problem must become clear to the instructor before he can guide students through the experience.

Impact on Course and Curriculum: The Department of Computer Science has successfully completed three such projects and plans to expand this initiative in the future, including exposing students to problem-based active learning and continuing throughout other courses in the department.

Lessons Learned: Real business partners added so much to the students' learning. The business partner in this case was very responsive.

The instructor noted that it is important to define clear expectations. The business partner's expectations and the instructor's expectations should match.

The instructor noted that it is important to define clear expectations. The business partner's expectations and the instructor's expectations should match.

The business partner noted that they had benefited from their experience with their "education partner." The student teams brought a fresh set of creative ideas to help solve the business problem.

Using PBCL in a Foundations Course

Background Information:

Course Description: In a four-hour Microcomputer Database Programming (Access) course taught at a community college, students use Access to learn the concepts and syntax of relational database management and SQL concepts. This is an introductory course that builds strong skills in SQL language. Prerequisite: Program Logic and Design (Systems).

Situation: The business problem came from a client, a global manufacturing company that uses a vendor for its computer services activities. The client and vendor wanted to analyze the vendor's fees to determine how much was being paid for the IT services, what were the biggest expense points, and to confirm that the client was getting a good value. The company wanted to use these analyses to highlight trends in spending and make decisions about how to improve their systems.

Though the voluminous data were available, the information was difficult to extract. The situation was, in essence, that the company was "data rich but information poor."



Learning Experience:

Three business partner representatives gave a Power Point presentation that introduced their company and its products, and gave some information about the situation that had brought them to the class. They challenged the students to work with the client's analysts to develop a data analysis tool that would help the company make better use of their resources.

The instructor felt that in the two-hour time period, the business partner devoted too much time to the overview of the company and too little time to the actual business problem. When students began to work in teams, the instructor reported that they were frustrated. They participated in weekly conference calls and were able to ask questions. The business partner gave feedback during these progress updates, but the instructor stated, "The problem was simply beyond the scope of this introductory class."

The instructor did not use most of the instructional resource tools. However, she did report that students had watched a film to prepare them for problem-based case learning, and she had led them in team-building skills to prepare for working the business problem.

Students who already had additional skills were the ones who came up with solutions. Students dropped out of the class because of the high level of frustration. By the end, there were only two teams left. One team leader used VB in his solution, and another team leader who had owned his own business came up with a solution, but the other team members did not contribute significantly.

A different perspective came from one of the business partners who worked closely with the class.

A different perspective came from one of the business partners who worked closely with the class. He participated in the weekly conference calls and was present for the final presentations by the two teams and was impressed with the solutions by the two teams.

Results:

Impact on Students: The students did not develop the skills they should have developed in this class, the instructor reported. At the time she was conducting this class, she was teaching a control group that did not use problem-based case learning. The control group covered much more material and developed stronger skills in SQL. The students working the PBCS were not as prepared for the workplace as the control group, the instructor stated, and they were not prepared for the next level course.

Impact on Teaching: The instructor's approach was always hands-on, and she always supplemented the text with outside assignments. Her students always worked in teams. This experience did not change her methods in any significant way, but she probably uses more teamwork now than she did previously.

Impact on Course and Curriculum: The only change indicated by the instructor is that she has put a two-week project into the course that will let students apply at the end of the semester what they have learned.

Lessons Learned: The business problem was inappropriate for this foundation class, the instructor emphasized. She stated that the students did not have the skills in this introductory course to work this problem. They lost 6-8 class periods due to the preparation for and implementation of the business problem. They missed two major assignments that the instructor felt were more valuable than this experience.

If there had been a second level Access course, the instructor believed this business problem would have worked in that class - but not in a foundation course.

The business problem was inappropriate for this foundation class... the students did not have the skills in this introductory course to work this problem

The instructor did not know until the first week of school that she was expected to use this business problem in her class. She noted that more lead time would have been a great benefit.

Working Toward Authentic Business Connections

Background Information:

BATEC, The Boston Area Advanced Technological Connections, is a collaboration and partnership among academia, industry, and community. Like CITE, BATEC is an NSF/ATE regional center whose goal is to develop and promote a regional IT educational system that will attract students to IT careers and support the IT needs of the region. To that end, BATEC conducted a four-day Summer Institute in 2004. One of the tracks in the Institute focused on problem-based case learning (PBCL) methodology. CITE representatives led the sessions designed to give instructors from the BATEC institutions the pedagogy, background, and context for using PBCL in their classrooms. Topics covered: how people learn, methods for promoting adaptive expertise, the learning cycle, developing starter units for scaffolding learning, common misconceptions and challenges, and how to generate cases for starter units. An instructor from one of the CITE partner institutions provided peer perspective by presenting a CSS project that she had used with her classes.



Experience:

The instructors who came to the workshop were not implementing any problem-based case learning. They generally relied on their textbooks and on the situations presented in the text. They came with the goal of improving their delivery of technical and soft skills, so they were "open and eager," according to an adjunct instructor at one of the BATEC community colleges. Participants had the opportunity for hands-on experiences; they actually produced materials (an exercise or a starter unit) to use in their classes, incorporating one or more aspects of what they learned in the workshop.

Results:

Impact on Students: The instructor stated that PBCL has definitely made a difference in student learning. In her advanced applications classes, students are more engaged, more committed - there is a level of excitement about learning. She said, "I like creative thinking and problem solving. I like that it's OK to make mistakes." She believes that PBCL "builds a better whole person."

...students are more engaged, more committed - there is a level of excitement about learning.

She used PBCL with both introductory and advanced classes. The first-year classes did not work as well. Students in the advanced classes had "a better sense of the workplace and the value of problem solving, teamwork, and creative thinking," the instructor noted. However, she pointed out that even though it is more difficult to use PBCL with the intro classes, as they go on to more

advanced classes, they "are demonstrating the effectiveness of the initial exposure to PBCL methodology."

Impact on Teaching: The instructor taught word processing applications, spreadsheet applications, and database applications courses. She had sent students out to find business problems because she wanted to introduce "real world" situations into her classes, but the methodology that she was introduced to at the Summer Institute caused "a little bit of a right turn" in her teaching. She quickly grasped how to develop scenarios to dramatize situations, and she continues to write scenarios, which she described as "fun and easy."

...even though it is more difficult to use PBCL with the intro classes, as they go on to more advanced classes, they "are demonstrating the effectiveness of the initial exposure to PBCL methodology."

The biggest challenge for the BATEC instructors is making authentic business/industry connections. The instructors did not "get the method for making connections."

Impact on Course/Curriculum: The Dean at this instructor's college has made a real push to use PBCL in the IT courses, and he encouraged the faculty to attend the Summer Institute.

They are making strides. They share their ideas with each other. Several of the faculty have developed scenarios.

BATEC has plans to develop more professional development opportunities for faculty to learn how to use PBCL methodology.

Lessons Learned: The Institute helped BATEC instructors understand PBCL methodology but they didn't get to the point of learning how to contact business/industry and bring a real-time problem into a classroom. Perhaps the faculty members don't have the time but, according to the instructor, they "just really don't have the wherewithall to do it."

Scenario-based learning has value but is not the same as using authentic business problems, as this instructor realized. She said, "This is what interests me - being authentic." The "real world, real time" situations are what distinguish problem-based case learning from scenario-based learning.

"This is what interests me - being authentic." The "real world, real time" situations are what distinguish problem-based case learning from scenario-based learning.

Changing Teachers, Too

Background Information:

Course Description: In a Program Logic and Design class at a community college, students learn the correct structure of a flow chart that will solve a business problem to meet reporting, data entry or updating needs; learn the proper symbols of flow charting and proper syntax for pseudocode; and use C-language to implement their plan. Prerequisite: Knowledge of DOS and WINDOWS. Corequisite: Computer Operating Systems Environments.

Situation: The components used in this class were based on a business problem that came from a pizza company and their consultant. The company, which locates pizza kiosks in convenience markets, had contracted with a consultant to set up a "training university" for their employees and track all of their in-house professional development. In this introductory class, the instructor developed units to teach basic skills, using this authentic situation.



Learning Experience:

The instructor framed the business problem by using two scenarios depicting Help Desk employees responding to problems via phone, one knowledgeable and helpful, the other confused and confusing. The scenarios got the students involved in the experience, and they were enthusiastic. The class was divided into four units in which the following skills were developed: (1) creating and using fields, records, files, and field types; (2) using a printer spacing chart to create a report layout; (3) creating a flow chart to show steps necessary to print a report, and (4) using keys to link files, to simulate a database. Students worked both individually and in teams. They made small-scale presentations at the end of each unit.

Results:

Impact on Students: Students developed the basic skills in Program Logic and Design by working through each of the units; they learned how to use the tools that will be required in advanced courses. By using the information and materials from the business situation, they experienced what it would be like in the "real world." They gained skills in teamwork and in problem-solving.

Some of the quieter students emerged, "picked up the ball," during this experience.

Students developed the basic skills in Program Logic and Design by working through each of the units; they learned how to use the tools that will be required in advanced courses.

At the end of the semester, they were required to do a transfer task, and the results were very positive in terms of transference skills. They were presented with a business situation and required to work in teams to come up with solutions and make recommendations.

Impact on Teaching: The instructor reported that she came into the teaching environment as a good programmer but a poor teacher. In fact, she was going to quit the profession at one point, but working with problem-based cases has motivated her and changed her attitude and approach. She had always brought in problems from the "real world" but did not use teamwork.

The biggest impact on her teaching, she commented, has been the change from thinking just about content to thinking about involving students, making them feel safe so they will be willing to ask questions, even to fail.

Impact on Course and Curriculum:

Lessons Learned: The instructor stated that time is certainly a factor when using the problem-based case approach. There is not enough time to stay ahead of the students. Also, technology changes, and just about the time you create "something wonderful," things change.

The biggest impact on her teaching, she commented, has been the change from thinking just about content to thinking about involving students, making them feel safe so they will be willing to ask questions, even to fail.



Preparing Students for Real-World Knowledge Gaps

Background Information:

Course Description: An Architectural Design Process class at a community college is intended primarily for students who will do design development at architectural firms. The purpose of the course is to allow students to experience the steps that architects go through to get the project to the design development stage. The course fulfills an ABET requirement for architectural design by bringing students in contact with a client who needs to establish a program. Students work with the client to establish an architectural program which includes a budget and site analysis. They work through the programmatic stage and preliminary schematic stage. They learn to deal with an adjacency matrix, zoning of spaces, and grossing factors. They learn to do a comparative analysis of sites, and they prepare a model (electronic or 3D). Prerequisite: Residential drafting/construction and Commercial drafting/construction.



Situation: The business problem came from a graduate of a business program who wanted to be an entrepreneur and had decided to start a daycare center. She approached the instructor about designing the building. She did not have a site, a budget, or any specific details about her requirements for the facility. The instructor used this business situation to develop a problem for his class that would give students real-world experience in determining programmatic information, assessing the information, and using it as the basis to prepare the conceptual design of a facility which they ultimately presented to their peers.

Learning Experience:

Although the business partner did not actually meet with the class, the instructor presented the authentic business situation in which he had been personally involved. He began by emphasizing teamwork as an essential part of the architectural office, where architects and various engineering disciplines work together on projects. The students were presented with four scenarios (which have been made into media pieces) to introduce the situation. For the first three weeks, the instructor gave very little direction, forcing them to research and gather information from whatever sources they could find. After they had struggled to learn exactly what an architectural program was, the instructor introduced a PowerPoint about programming and pointed them to examples of programs. Students worked in teams, first through the programming stage, in which they learned to prepare an adjacency matrix and to deal with zoning requirements and grossing factors; they also prepared a budget for the project. Next they worked through the site analysis stage, in which they did a comparative analysis of two

...the students were, absolutely, better prepared for the real world of work because their classroom experience closely simulated an architectural office. Students had no study packets, no safety net.

sites and recommended one of the sites. Finally, they prepared a schematic design, with a model that could be electronic or 3D. Each team did a presentation after each stage of the project.

Results:

Impact on Students: The instructor stated that the students were, absolutely, better prepared for the real world of work because their classroom experience closely simulated an architectural office. Students had no study packets, no safety net. Although they often complained about the extra time involved, in the end, they learned to take initiative, and many experienced being in a leadership role for the first time.

They developed the skills that they were supposed to develop in the course and went beyond, learning to "figure out" things for themselves that were not specifically part of the course. The course pushed them to find subject matter experts rather than depending on the instructor. For example, they took the initiative to bring in an expert on "green architecture," who presented information on how to design energy-efficient HVAC systems. The instructor, as well as the students, learned about using water runoff, water recycling, and reclaimed land for environmentally-sensitive design. Students realized that the "expert" brought something to the course that they would not have learned from the instructor. Another example of how the course pushed them was their Internet search to find sites. Internet skills were not built into the course, but students discovered for themselves how to get an Internet map and how to produce an AutoCaD drawing from the map.

They developed the skills that they were supposed to develop in the course and went beyond, learning to "figure out" things for themselves that were not specifically part of the course.

The problem-based case learning experience gave students knowledge, skills, and attitudes that the instructor believes will transfer to other courses and other situations.

Impact on Teaching: The instructor actually began using case-based teaching after he did his master's program, which emphasized making the classroom experience simulate a work experience. This situation has validated what he has been trying to accomplish. It has given him tools and techniques to expand his approach. He believes now that it is his responsibility to make students aware of the knowledge gap - the gap between what they know and what they need to know. He said, "Previously my goal was to fill the gap." Now his goal is to prepare students for the many knowledge gaps they will encounter in the workplace. The best way to prepare them is through letting them find out things for themselves.

Impact on Course and Curriculum: He will definitely use this situation again and continue to develop others for the course. The business problem opened up a way to teach content that the curriculum was not providing. Previously this course was a third "design development" course, but now students are exposed to programming and schematic design.

Lessons Learned: "You need to do more than one," the instructor stated. Competency comes with experience, and after the first one, he believes it is easy to move to another problem-based case.

"Just jump in and do it," he said. He believes that students benefit even if there are problems encountered in the course.

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Additional Resources

For additional information about CITE and the associated ATE project at Nashville State referenced in this study, please visit our website: www.cite-tn.org

A companion study entitled *Developmental journeys moving problem-based case learning to real time: Implications for teacher learning and professional development* examines the CSS experience and lessons learned from the perspective of learning scientists. Copies will be available Spring 2006 directly from the CITE website.

For more information about problem-based learning and research into how people learn, please reference the following:

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