Aligning Workforce Skills with Industry Needs Through Problem-Based Learning Environments

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Abstract

Industry continues to require more of workers. The skills it takes to get, and keep, a job in the global marketplace for labor are expanding. For no group is this truer than for the Information and Communications Technology (ICT) workforce. Due to the advances in information technology (IT) applications, nearly all business practices today are "IT-enabled." There is continued demand for skilled ICT workers, but largely only those who possess both ICT skills and a range of employability (soft) skills that add value to their work. The maturing of IT jobs calls for the integration of employability skills with technical skills.

The Boston Advanced Technological Education Connections (BATEC) Workforce Skills Study, along with independent research by industry trade groups indicate more holistic teaching methods that involve students in complex problems developed from industry input are in order. In fact, the only plausible way to cover competencies in both areas is to develop a problem-based learning scenario that enables students to learn within a context, integrating real-world business problems into ICT classrooms.

Classroom research and evaluation findings from a problem-based learning implementation for the purpose of infusing employability skills indicate that students are being taught problem solving and critical thinking skills through the use of project-based learning in introductory IT courses. By introducing project-based learning into introductory IT classes at two Colorado community colleges, hundreds of students are mastering academic competencies in the context of solving "real world" problems that require collaboration, problem solving, critical thinking and other employability skills. Teachers report that students engaged in project-based learning are energized in new ways and demonstrate improved learning outcomes. Classroom research has been, and continues to be, conducted to document these results. External evaluation extended throughout the first three years of the implementation.

This paper provides the steps taken by two community colleges to infuse employability skills into their introductory Computer Information Systems (CIS) classes via problem-based learning. The authors outline how the employability skills were identified and vetted with industry; how faculty were engaged and prepared for a change in mindset, as well as in curricular design and implementation; the framework of the real-world project; and the differences this approach continues to make in students' understanding and application of the skills they need to be competitive in the global marketplace.

The National Science Foundation Advanced Technological Education (NSF ATE) program funding for the project that initiated this work ended in August of 2011, and follow-through by CIS faculty in continuing the problem-based learning methodology has been inconsistent.

Introduction

Two metro-Denver community colleges participated in the Colorado ATE Partnership (CATEP) in order to advance technician education in the region. This NSF/ATE-funded project (DUE #0802439)[1] had a shared vision to develop a model for Information and Communications Technology (ICT) responsive to the workforce needs of the metro-Denver region's high growth industries. Aims Community College (Aims) and Arapahoe Community College (ACC) collaborated to form the CATEP partnership. The primary goal of the project was to strengthen the Computer Information System (CIS) introductory curriculum at both institutions, along with associated Career and Technical Education (CTE) courses, to better prepare technicians for the workforce.

Vetting of employability skills

The integration of employability (soft) skills with the technical skills employers report they need for their ICT workforce served as the foundation for curricular design and implementation. While employability skills may be categorized in many different ways, for the purpose of the CATEP project, they were clustered into five main areas: communication skills; critical thinking and problem-solving skills; teamwork and collaboration skills; contextual knowledge of work responsibilities; and self-management/motivation skills.

Research conducted by the National Workforce Center for Emerging Technologies (NWCET),[2] the Boston Area Advanced Technological Education Connections (BATEC) Workforce Skills Study[3] and the metro-Denver Workforce Innovation in Regional Economic Development (WIRED) Initiative[4] provided the impetus for the project. These studies confirmed the need to integrate technical, analytical, and employability skills. CATEP worked closely with industry to further identify the specific employability skills the region's industries need in their ICT workforce. Additionally, independent research by industry trade groups such as the Information Technology Association of America (ITAA)[5] and the Society for Information Management (SIM)[6] shows that for American ICT workers to remain competitive, they must offer skill sets beyond the basic knowledge of a specific IT discipline.

BATEC's IT Workforce Skills Study notes that the industries they surveyed consider technical skills as important as ever to the technicians they plan to hire. Employers note, however, that the successful candidates will be those workers who possess employability skills, especially critical thinking, problem-solving, communication, knowledge of business processes, teamwork, and a good work ethic, that can leverage the technical skills for greater impact for both the company

and the worker. Likewise, through their survey of 200 companies (2006), the metro-Denver WIRED Initiative discovered a need for technical workers with a broader-than-expected range of skills, i.e. a call for technical workers to have solid writing, marketing, leadership, or sales skills. When evaluating job applicants, businesses surveyed indicated they value experience and skills, most, and find that applicants do not have the required written and verbal communication skills they need to be viable candidates. Based on a 2007 study, the Indiana Business Research Center predicted that into 2014 the skills in highest demand in contrast to technical skills would include persuasion, negotiation, complex problem-solving, time management, and decision making.[7]

The BATEC study points out a question that continually plagues technician educators: "How can students be trained in required technical competencies and acquire employability skills at the same time, when the time to complete training is so limited?" BATEC's and NWCET's research indicates that more holistic teaching methods are appropriate to involve students in complex problems they will face when they are on the job. Indeed, this technique is the only plausible way for educators to cover both competencies – the technical aspects of the curriculum needed to get an interview *and* the skills needed to get (and keep) a job.

The focus of the CATEP project was to provide potential workers with employability skills that would equip them with the intellectual capital required to fill the high-skill/high-wage jobs in the metro-Denver region. Quality engagement with industry at all critical points in the instructional process contributed to developing project-based learning (PBL) to develop soft skills, transferable IT skills and the ability to adapt to an ever-changing workforce. CATEP has surveyed high-growth industry businesses in the respective colleges' regions regarding the skills (beyond basic IT skills) needed by their incumbent ICT workers. A "super set" of employability skills have been captured from, and validated by, industry partners. This skill set is not unique to IT but rather is broadly applicable to technician education. The industry-validated skill set is an outstanding product of the CATEP project and is displayed below:

- *Written communication*
  Use of a computer application to enter text, graphics, and other formatted information
  Formatting, editing, and printing information using a computer application
  Correct spelling, grammar, and articulation in the presentation of information and ideas

- *Verbal communication*
  Persuasive expression of ideas/data to customers, co-workers, and management clearly and succinctly, through effective use of eye-contact and non-verbal expression in daily contacts and at meetings
  Presentation skills (including dress, knowledge of subject, knowledge of audience, persuasiveness, voice projection, eye contact, body movement, stance, pointer use, etc.)

- *Work and personal ethics, values, and standards*

Honesty/integrity with respect to company time and property (real or intellectual)

Loyalty to company, team, and co-workers

Commitment to doing your best and what is best for the company and customer

Enthusiasm in assigned tasks

Reliability and dependability in terms of consistency, meeting deadlines, and getting the job done

Maintain a sense of humor

Maintain a positive attitude

Be responsible and accountable for your actions and the actions of your group/team

Use common sense when necessary

Convey a sense of self-esteem and confidence

Maintain a high personal standard of quality work

Embrace and celebrate diversity

Treat customers (external and internal), subordinates, co-workers, and management with respect

Use of appropriate verbal and body language in the workplace

Use of good manners

Demonstrate promptness (i.e. show up on time or communicate, if late)

Avoid absenteeism

Eliminate distractions during meetings/gatherings (e.g. cell phones, iPods, Blackberries)

Respect confidentiality of work and personnel issues

Do not plagiarize

Do not attend to personal business on the job

Adhere to company dress code

Maintain appropriate grooming and hygiene

Be aware of personal and group health and safety issues and act accordingly

Develop a rapport with others and establish and maintain working relationships

Listen effectively to others when they speak

Understand human motivation

Understand and respect cultural differences, internally and externally

Manage stressful situations effectively (i.e. maintain "calm")

Ability to multi-task effectively and efficiently

Coordinate and give structure to things or tasks

Ability to vary or adjust style or approach according to situational demands

Seek balance in all life aspects, including health and fitness

- *Self-motivation and initiative*
  Willingness to learn new skills and tasks via study, experience, or training
  Willingness to take on additional work load
  Show initiative in carrying out work assignments
  Take responsibility for completing one's own work assignment(s)

Be creative and originate or imagine new ideas, methods, or products
Be pro-active in career planning

- *Listening and using information*
  Listen attentively with appropriate eye contact
  Ability to take efficient and thorough notes
  Appreciate feelings and concern of verbal messages
  Pick out important information in verbal messages
  Understand complex messages
  Review information for relevance and completeness
  Recognize and take steps to eliminate important gaps in existing information

- *Willingness to learn*
  Learn from your mistakes and accept help from co-workers and supervisors
  Learn new/additional skills related to the job
  Learn about the products or services of the organization
  Plan for, and achieve, your own learning goals

- *Teamwork and collaboration*
  Work as part of a team to achieve mutual/common goals through contribution and collaboration
  Develop and maintain good working relationships with co-workers and supervisors
  Choose behaviors that best support the team and lead toward the accomplishment of work tasks
  Work through conflict constructively
  Persuasively present thoughts and ideas to other team members
  Respect the views of others on the team
  Build toward team consensus
  Understand and respect the diversity among team members
  Collaborate effectively with others on individual assignments

- *Leadership*
  Ability to effectively and positively influence the performance of teammates and co-workers
  Ability and willingness to take the lead when offered or needed
  Ability to lead and/or supervise a diverse workforce

- *Critical thinking and problem-solving*
  Apply Root Cause Analysis whenever possible
  Recognize the human, interpersonal, technical, and scientific dimensions of a problem
  Apply logic, reasoning, and critical thinking skills to review information, identify problems, and select the best solution(s)

Contribute to solving problems through suggestions, recommendations, and communication

Faculty preparation

Faculty preparation for infusing employability skills into introductory CIS classes involved collaboration with other NSF/ATE-funded projects. Both ACC and Aims worked closely with BATEC to understand their process for implementing problem-based learning, designing rubrics for evaluating student performance, the coordination/facilitation of project teams, and final project presentation for dissemination to class members and educators interested in duplicating the project. Faculty from both schools involved in the project also participated in "Getting Results" training prior to introducing employability skills into course curriculum. The training emphasized the effectiveness of PBL to achieve educational outcomes.

Lead instructors for the CATEP project from ACC and Aims expanded their expertise in PBL through participation in the *Roots & Wings Instructional Leadership Institute* initiated by the SC ATE Center of Excellence. The Institute includes participant design of problem-based learning scenarios, tasks, and assessments to enrich technological education in their classrooms. Through the process, they became trainers for other faculty. Educational Design consultants from the BATEC project also conducted workshops for ACC and Aims faculty at the ACC campus. These professional development sessions had as their focus contemporary, cutting-edge, no-cost products available to faculty to enhance employability skills training for students *and* faculty.

Faculty engagement

Faculty at both ACC and Aims struggled with the realities pointed out by the workforce skills' studies mentioned previously. Essentially, integrating employability skills into current coursework was challenging, both in terms of mindset and workload. However, CIS instructional staff at Bunker Hill Community College in Boston (a BATEC partner) provided invaluable information and training toward curriculum redesign and best practices for better preparing students to enter the ICT workforce and move up the career ladder. More specifically, they implemented projects in their introductory CIS classes that introduced students to "real world" scenarios requiring the application of Microsoft Office Suite Skills. ACC and Aims faculty were trained on a project-based learning case that involved students working collaboratively, but assessed on an individual basis, just as they would on a real-world business project. This experience proved crucial to faculty understanding the infusion of employability skills into an existing curriculum and being fully engaged toward altering their teaching methods.

The PBL scenario

Initially, CATEP modified BATEC's PBL project to integrate employability skills into introductory CIS classes. Ultimately, Aims Community College faculty developed a new project-based learning scenario – the International Travel Project (ITP) created specifically to fulfill the objectives of the CATEP project. In keeping with the PBL instructional approach, the ITP is student-centered, driving students to take an active role in their learning. The basic premise is that there is not a pre-determined solution to the problem posed by the project. Students must work collaboratively, be cognizant of their work responsibilities, open their minds to alternative solutions, review and critique the work of their peers, learning employability skills in the process. The International Travel Project was introduced in all face-to-face classes in the fall of 2009 and expanded to some online sections in the spring of 2012. Constructive student and faculty feedback, along with successes in outcome achievement, have refined project activities and kept the PBL technique going strong in selected CIS classes at both institutions. Faculty who have continued the PBL approach in their classes have seen stronger achievement of student outcomes than those who didn't (see Figure 2).

The ITP is built upon "authentic learning activities," giving students an opportunity to collectively design a dream vacation and market it as a travel package to fellow classmates from the standpoint of a travel agency. Students are placed in teams of 3-to-4 and instructed to agree upon a business logo and select a country that, in their minds, would offer the most enticing attractions in terms of a given theme – food, museums, vineyards, biking, shopping, etc. Every aspect of travel is to be considered in the travel package; i.e. length of stay, currency exchange rates, transportation, lodging, meals, excursions, etc.

The selected country and theme, along with stipulations about the time of the year the trip would be offered and affordability to families/individuals classified as lower middle class, provide the framework within which Microsoft Office Suite competencies can be applied. It is the prerogative of the instructor to align the Microsoft Office applications required to be used in completing the project; students are also given creative leeway to use any other Microsoft Office applications they believe will position their project as most attractive to their target audience (their classmates). For example, students might want to create a travel brochure in Microsoft Word, a comparative table of transportation and lodging expenses in Microsoft Excel or a chart of those expenses, or perhaps maintain an Access database of "phantom" customers' positive assessments of previous trips planned by the travel agency. The PowerPoint presentation is required of all teams to display these persuasive materials to prospective travelers.

Teams draw up a contract outlining ground rules for team assignments/behavior and the plan for their project; team meetings are required, with minutes submitted to the instructor and reviewed to ensure the team is on track to fulfill the "terms" of their contract. From the outset, students

are working to achieve a common goal: Use Microsoft Office Suite skills to convince fellow classmates that their team has the best travel package.

The application of employability skills is inherent in the design of the project. As noted, students work as a team to name their business, settle on a logo, decide their country of choice, determine Microsoft Office Suite applications that might enhance their project but are not required for the completion of the project, etc. Obviously, communication skills are crucial to the successful completion of the project as are research and inquiry skills (geography/attractions), organization, teamwork and time management skills, leadership skills and presentation skills. Business attire is required for the team presentation at the conclusion of the project.

The authentic learning activities embedded in the project reflect the routine activities of today's workplace and emphasize many of the same employability skills industry identified in the "super set." Rubrics have been designed to help bridge the gap for students between project directions and project outcomes. Additionally, faculty have determined that the project should be assessed intermittently throughout the course of the semester. This has given faculty insight into each group's management and communication styles, as well as the degree to which the technical aspects of the course are being grasped and mastered. Essentially, periodic assessment enabled students and faculty to continue to be engaged. Evaluation of the project consists of several components:
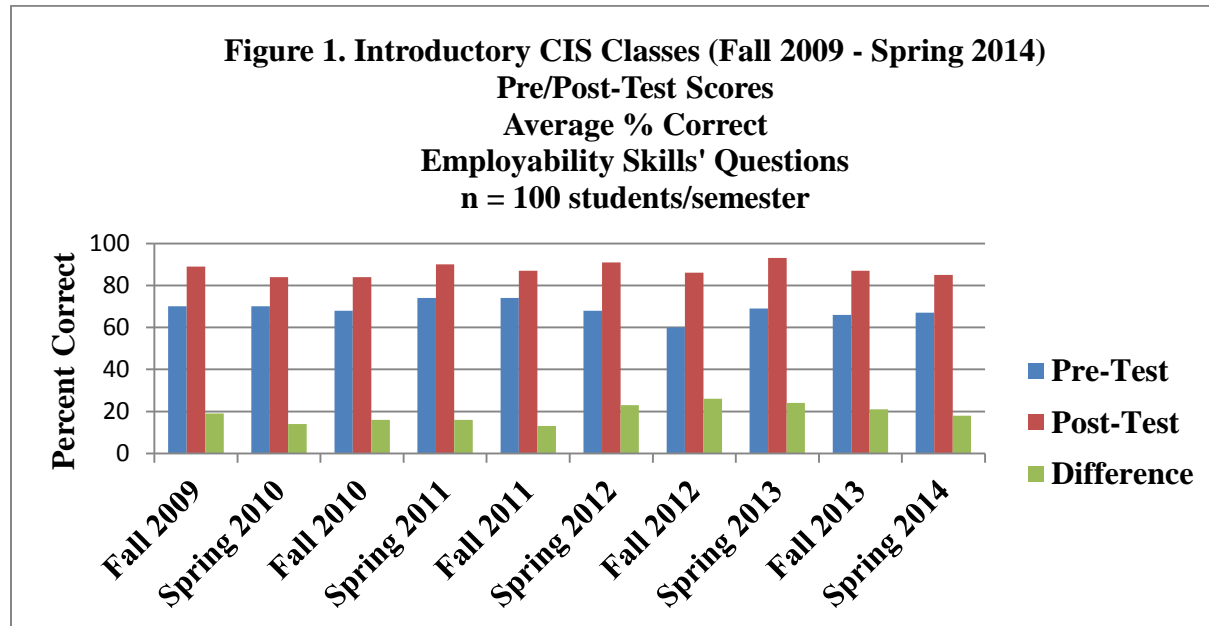
- students evaluate each of the other members of their team in secrecy and submit their assessments at the end of the project;
- instructors review the team contract, making sure ground rules have been defined and are acceptable, and that required competencies will be met;
- instructors intermittently review team progress to ensure the project is on track, plus gather student feedback to improve the learning experience; and
- students determine the "winning" project based upon team presentations at the end of the project.

Challenges

The idea of projecting their own ideas and opinions into an assignment, not to mention making decisions that affect project outcomes, was difficult for some students. For others, layering an unfamiliar learning technique on top of Microsoft Office Suite competencies was somewhat overwhelming. Many students were not familiar with a collaborative learning scenario or how to create and share defendable work. As is typical of all students, some completed the bare minimum in terms of course requirements; others found the PBL approach gave them far more flexibility, with an opportunity to take their learning beyond what a traditional learning environment would allow. As one student involved in the PBL classes put it, "…PBL gave us an opportunity to gain confidence as problem solvers."

Victories

On the positive side, introducing the PBL approach into the CIS 118 course stimulated the creative juices of faculty, as well. For example, they became interested in the work of experienced PBL practitioners designed to heighten student interest and motivation, ultimately improving the achievement of course outcomes. The introduction of PBL into the CIS curriculum has improved students' grasp of the employability skills necessary to survive in the workplace. A comparison of the average percentage of correct answers to pre/post-test

Figure 1. Introductory CIS Classes (Fall 2009 - Spring 2014)
Pre/Post-Test Scores
Average % Correct
Employability Skills' Questions
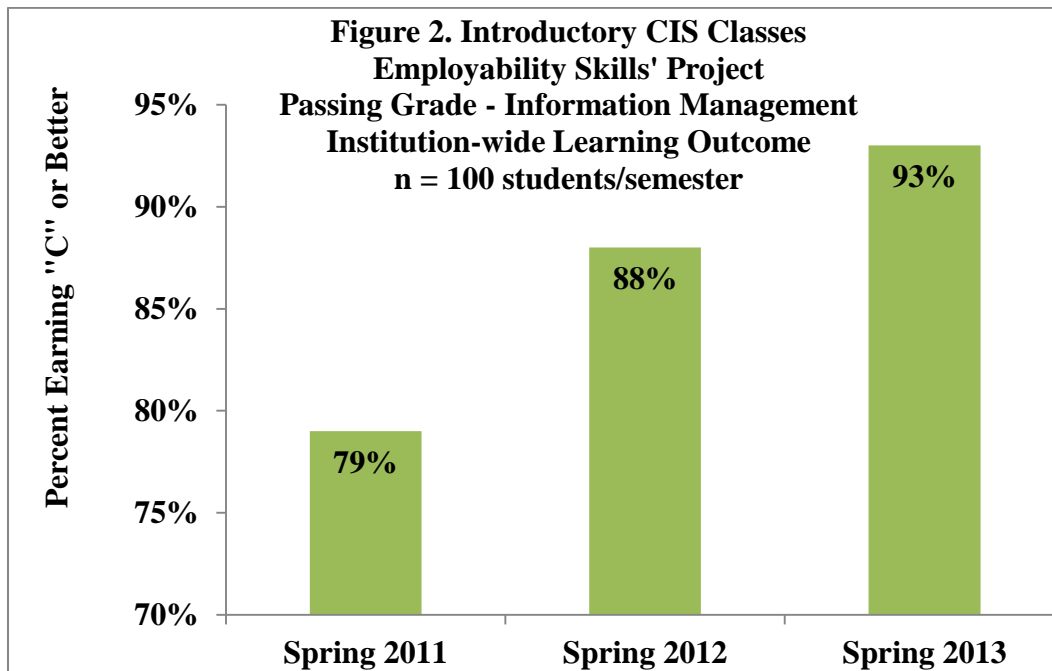**n = 100 students/semester**

questions focused on employability skills for the introductory CIS course from fall 2009 – spring 2014 is shown in the graph above. Although the PBL scenario was implemented by both Aims and ACC, the data includes students enrolled at ACC, only.

Since the introduction of PBL to infuse employability skills into the CIS course and curriculum, students have scored higher on the post-test than on the pre-test when considering questions having an employability skills' focus. Specifically, those questions deal with whether job interviewees should educate themselves about the company with whom they are interviewing *prior* to the interview; the appropriate format/subject matter to be included in a resume; proper attire for an interview; the importance of arriving at an interview on time; and the cluster of traits employers look for in a new hire, i.e. technical skills, soft skills, or both. Gains have ranged from 15 to 26 percentage points in the average number of employability skills' questions students answered correctly over the 5-years of longitudinal data depicted in Figure 1.

There is no significant difference in the persistence rates, from one semester to the next, when figures are compared for students in the introductory CIS classes prior to the infusion of

employability skills into the curriculum. Introductory CIS students in classes continuing the ITP beyond the conclusion of the CATEP Project have performed well in relation to the Information Management Student Learning Outcome. The trend from spring 2011 – spring 2013 is depicted in Figure 2 below. Progress in this area is directly related to PBL. The outcome was measured, and grades assigned, according to the ability of students to create, modify, use and print word processing documents, spreadsheets, and databases and make presentations incorporating these skills. In that regard, faculty note that students are significantly more engaged in their work when they are able to experience real-world implementation of academic concepts.

Figure 2. Introductory CIS Classes Employability Skills' Project Passing Grade - Information Management Institution-wide Learning Outcome n = 100 students/semester

A bar chart titled "Figure 2. Introductory CIS Classes Employability Skills' Project Passing Grade - Information Management Institution-wide Learning Outcome n = 100 students/semester." The y-axis is labeled "Percent Earning "C" or Better" ranging from 70% to 95%. Spring 2011 = 79%, Spring 2012 = 88%, Spring 2013 = 93%.

Evaluation findings and conclusion

The final external evaluation report for the CATEP Project stated, "CATEP has built a recruitment pipeline for students entering the rejuvenated CIS programs. While the full impact of CATEP outreach efforts will not be known for several years, enrollment data reflect program growth and consistently strong enrollments in the target courses. Positive student enrollment trends will help garner the necessary departmental and institutional support for sustaining CATEP innovations that include the use of project-based learning and internships." A faculty member who strongly supported and was fully engaged in the classroom innovation launched by CATEP continues to track improvements in student learning semester after semester, long after the project ended. Data collected and shared herein therefore reflects the impact of the project and lasting change that is possible with consistent implementation of project-based learning. The CATEP model employing problem-based learning methodology demonstrates a successful way to infuse workplace readiness skills, increase student engagement and success rates, and provide

employees that demonstrate a comprehensive set of soft skills and knowledge required by today's employers.

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