Volume 15, No. 4
July 2017
ISSN: 1545-679X

INFORMATION SYSTEMS EDUCATION JOURNAL

In this issue:

The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **EDSIG**, the Education Special Interest Group of AITP, the Association of Information Technology Professionals (Chicago, Illinois). Publishing frequency is six times per year. The first year of publication was 2003.

ISEDJ is published online (http://isedj.org). Our sister publication, the Proceedings of EDSIGCon (http://www.edsigcon.org) features all papers, panels, workshops, and presentations from the conference.

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INFORMATION SYSTEMS EDUCATION JOURNAL

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Role-Playing and Problem-Based Learning: The Use of Cross-Functional Student Teams in Business Application Development

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Abstract

To create a learning experience which replicates the process by which consultants, systems developers and business end users collaborate to design and implement a business application, a cross-functional student team project was developed and is described. The overall learning experience was distinguished by specific components and characteristics of the project, including: 1) a problem-based learning approach which presented students with an accounting auditing problem requiring the design and development of computer-based application from scratch; 2) the formation of cross-functional teams comprised of students across multiple sections of two different courses (the capstone courses for both Accounting and Information Systems); and 3) the contributions of individual students based on their respective backgrounds and roles in the project. The roles included domain/content experts (accounting students) as well as consultants, business analysts and developers (information systems students). The intentional use of cross-functional teams and assigned roles distinguishes this approach from other problem-based approaches. Further, the teams had additional extrinsic motivation as the business applications they developed could be submitted to a contest hosted by a professional organization. Pre- and post-assessment data indicate that students learned, through iteration and trial-and-error, new interpersonal, analytical and technical skills through client-consultant interactions, problem definition and formulation, requirements analysis, business process and data modeling and application development.

Keywords: information systems pedagogy, problem-based learning, business application development, cross-functional teams, capstone

1. INTRODUCTION

Given the increasing market demand for business students who possess skills in areas such as communication, collaboration, critical thinking, problem-solving and self-learning, educators are under increasing pressure to re-think traditional approaches that rely primarily on information delivery. Whether the information is delivered via lectures, chapter readings, or online videos, these methods can be perceived as one-way communication and inhibit students from learning how to think, analyze, and move towards a problem solution in an unstructured, team-based environment – the very skills many professional jobs demand. Further, many companies are looking to newly minted graduates to take a highly active role in existing teams within the organization, and thus students need to have practice working effectively in a collaborative environment.

As an alternative, problem-based learning methods, which focus students on the knowledge and skills required to solve a particular problem, can be effective in instilling many of the self-learning skills required of business graduates (Smith, 2005). Certain business disciplines in turn are highly conducive to the use of problem-based learning because they naturally incorporate many of its elements. The analysis, design and development of a business application, for example, is an inherently collaborative, complex and unstructured task requiring the interaction of many different types of skills and knowledge that no one person is likely to possess. It requires progressive understanding of business requirements through iterative communication with content experts, the design of a data and process model that aligns with and addresses the requirements, and the development of a technical solution that implements the model and solves the business problem. Thus, successful completion of this complex and multifaceted task is possible only through a cross-functional team in which the various members contribute their own specialized knowledge. This last point is critical, and the course project described below focuses on implementing this very concept. The course project, which required the development of an auditing web-based business application, could not have been easily implemented, if at all, within a single class. The Accounting students had the auditing knowledge but not the skills to develop the application. Conversely, the Information Systems (IS) students, who could develop a web-based business application, did not have knowledge of the auditing domain or the decision support requirements. Thus the only feasible solution was to combine students from both disciplines and encourage them to determine what they needed to know and to learn from each other and, secondarily, from their professors.

In this paper, we describe prior research on problem-based learning and its implementation in business education. Following this, we describe the context, motivation, and approach taken during implementation of the cross-functional course project. Lastly, we discuss learning outcomes and lessons learned to set expectations regarding the success of the course project as well as provide guidance if others are considering such an implementation.

2. LITERATURE REVIEW

Broadly defined, problem-based learning (PBL) focuses on the student, who in turn is tasked with conducting a detailed and iterative process of exploration, information gathering and analysis (Barrows, 1986). As such, and as Hmelo-Silver notes, problem-based learning involves students working together, in groups, in order to "learn what they need to know in order to solve a problem" (Hmelo-Silver, 2004).

On a deeper level, there are elements inherent to PBL that distinguish it from other problem-solving approaches and make it particularly relevant as the foundation for this student project. Those elements can be characterized as follows:

- **Unstructured nature of the task and problem**: Problem-based learning is most effective when the task facing the students is ill-structured. (Stinson & Milter, 1996; Walker & Leary, 2009) Hmelo-Silver and Barrows define an ill-structured problem as one that is not solved algorithmically, but rather presents students with the possibility of multiple 'correct' answers as well as various alternative paths to reach one or more of those solutions. As such, students are required not only to 'solve' the problem but also to defend the approach they took in finding their solution (Hmelo-Silver & Barrows, 2006).

- **Holistic learning outcomes**: Much of the benefit derived from PBL lies in its ability to integrate the various facets of a complex problem. PBL began in the field of medical education, which required educators to pursue a learning approach that could combine acquired medical knowledge as well as the patient-related and social factors

required for medical diagnosis (Barrows 86). This integrative characteristic of PBL that makes it useful for medical education also makes it suitable for other disciplines requiring the integration of multiple perspectives (Savery, 2006; Stinson & Milter, 1996).

- **Consultative role of the teacher**: In PBL teachers shift away from their traditional role as lecturers, and toward a less directive and more consultative, facilitative role (Walker & Leary, 2009). As such, the onus for solving the problem, and thus learning what is necessary in order to solve the problem, is placed squarely on the student.

- **Active role of the student**: As Walker and Leary explain, students must understand and formulate the problem, ascertain what they need to know in order to solve the problem, and then proceed to acquire that knowledge (Walker & Leary, 2009). Kay notes that broad complex problems require students to take a strategic approach in planning their learning strategy and communicating among group members (Kay et al., 2000; Savery, 2006).

- **Collaboration and interaction among students and teachers**: Somewhat related to the preceding two elements, the relationship between and among students and teachers is inherently collaborative. Hmelo-Silver and Barrows note that teachers using PBL are facilitators, but more specifically they are facilitators of "collaborative knowledge construction." (Hmelo-Silver & Barrows, 2006) Cockrell et al state that collaboration is "a central, organizing premise of PBL", in that it helps to link "theoretical knowledge" to "practical application". (Cockrell, Hughes Caplow, & Donaldson, 2000) They cite Vygotsky in arguing that because learning is "the social construction of knowledge," collaboration is an essential component of learning (Cockrell et al., 2000).

- **Focus on real-world and cross-disciplinary problems**: Scholars agree that problems investigated by students must have some type of relevance to the real-world, which allows students to combine theory with practice (Savery, 2006). Barrows and later Stinson and Milter defined a real-world problem as lying fundamentally within the context of professional practice (Barrows, 1986; Stinson & Milter, 1996) a context which Walker and Leary suggest is "inherently cross-disciplinary" (Walker & Leary, 2009).

PBL has been applied across a number of domains over the past 30 years, including the business and computer science disciplines that are closely related to this project. PBL is particularly applicable to business education largely because of the characteristics discussed above: It is multi-disciplinary, encourages collaboration and builds interpersonal skills, focuses on practice, and because of its relevance tends to motivate and excite students (Smith, 2005). It is in this sense that business education has been overly narrow, compartmentalized and lacking in real-world relevance, and thus has motivated a growing adoption of PBL in business education (Smith, 2005; Stinson & Milter, 1996).

Adoption in business education has occurred within two domains. The first is individual business disciplines such as accounting (Hansen, 2006; Johnstone & Biggs, 1998; Stanley & Marsden, 2012), marketing (Wee, Kek, & Kelley, 2003), organizational behavior (Miller, 2004), production/operations management (Kanet & Barut, 2003) and project management (Kloppenborg & Baucus, 2004). The second is graduate management education, which includes the creation and implementation of complex projects incorporating issues across various business disciplines. Stinson and Milter for example describe the use of PBL across the curriculum of the MBA program at Ohio University (Stinson & Milter, 1996). Brownell and Jameson describe a problem-based team project that they explain "has been the centerpiece of the Master of Management in Hospitality (MMH) curriculum" in the School of Hotel Administration at Cornell University (Brownell & Jameson, 2004). Sroufe and Ramos describe a 'thematic' approach to problem-based learning in the specialized MBA program in Sustainability at Duquesne University (Sroufe & Ramos, 2015). In each case the intent is to develop in graduate business students the real-world problem-solving, collaboration and leadership skills sought in the marketplace.

We should note that the project-orientation and technical component of our student project, which involved the design and development of a computer-based application, has also been addressed in the PBL literature. The fields of interest within this perspective are engineering and computer science which, like business, also require their graduates to develop solutions to complex problems (Kay et al., 2000; Mills &

Treagust, 2003; O'Grady, 2012) Similar to application development, Mills and Treagust explain the phased project approach, process orientation and design focus of many engineering projects (Mills & Treagust, 2003). Kay et al in turn cite analogous examples from computer science such as 'maintaining information about Olympic events and athletes and answering arbitrarily complex database queries" (Kay et al., 2000). These are very similar to the types of information management and reporting activities conducted by our student teams as part of the project.

3. CONTEXT AND MOTIVATION FOR THE CROSS-FUNCTIONAL TEAMS

The context for the course project included two capstone courses at a mid-size private university in the eastern United States. All of the students were undergraduate students nearing graduation and were either enrolled in the School of Business Administration or a program affiliated with the school. The four instructors cooperated to incorporate the course project into two capstone courses – the Accounting capstone and the Information Systems capstone. Prior work has examined the combination of capstone courses within more similar disciplines related to IS (Schwieger & Surendran, 2010) and integration of content from a major into a capstone (Reinicke, Janicki, & Gebauer, 2013).

Each instructor taught one section of a course, and two sections of each course were involved. No other sections of either course were offered during that semester. The course project was introduced towards the beginning of the semester in both courses and was included on the syllabus as a graded requirement of the course.

In addition to the grade-related motivation, students also had extrinsic motivation for completing the course project. The Pennsylvania Institute of Certified Public Accountants (PICPA) hosted a business application development contest for students, and the faculty emphasized the potential for students to submit their work. The deadline was conveniently aligned with the end of the academic semester. The PICPA invited college students in the Commonwealth of Pennsylvania to develop a web-based application that could provide automated decision support in the area of accounting, financial reporting and/or auditing. Completed applications could be submitted to the PICPA for review by their panel of experts, who in turn would award the first, second and third place winners from around the state and associated cash prizes.

Although the contest ostensibly was targeted to accounting students, it was clear from the start that while the senior accounting students had appropriate knowledge of the accounting/auditing domain, they did not have the knowledge or skills required to develop a web application. Thus, composing teams of students from both the capstone accounting course and the capstone IS course and developing a joint project where these cross-functional teams would develop applications for submission was formulated. The faculty believed that cross-functional teams would not only address the 'skills' issue, but also would inherently facilitate PBL by implicitly incorporating most if not all of the components of PBL. Note the following definition of a cross-functional team from the Institute of Management Accountants (emphasis added):

> "A cross-functional team is a small ***group of individuals*** that ***cross formal departmental boundaries*** and levels of hierarchy. The group is committed to a ***common purpose or goal*** of improvement; it acts and works as a unit — ***communicating*** frequently, cooperating and providing mutual support, ***coordinating*** activities, drawing upon and ***exploiting the skills and capabilities of the team*** while considering the needs of individual members." (IMA, 1994)

While the initial motivation for a joint project was almost purely practical – i.e., to assemble the resources required for students to submit a web application to the PICPA contest and to continue to satisfy the learning outcomes for the capstone courses, the faculty team quickly came to the conclusion that this project could be much more than that. The students could play a role in a project that would reflect what they could expect when they enter their professions. The accounting students would be the end users; i.e., the professional accountants in need of a decision support system. As such they would have to communicate their needs as well as the nuances and complexities of the decision task to the development team. The IS students, in turn, would be the development team; i.e., the consultants, business analysts and application developers who would have to glean the application requirements from the accountants, and iteratively develop and deliver an application to the accountants' satisfaction. Furthermore, the students would encounter many of the 'real world' issues and frustrations inherent in a systems development project. Students on both

sides – accounting and IS – would discover that they did not possess all of the knowledge and information required to deliver a working application. Therefore they would have to acquire that knowledge by questioning their professors, by sifting through white papers and technical documents, by engaging in internet searches, and through trial and error.

Given the relatively short period of time provided to build a business application from scratch – i.e., less than three months – the faculty team did not expect the students to produce production-quality applications immediately ready for use by professionals, but rather a prototype. The main intent was for students to engage in the entire process of developing the application, with the development process essentially becoming a proxy for the learning process and all of its elements, both technical and interpersonal. And while the faculty team expected, or at least anticipated, these outcomes, the project produced other outcomes, both positive and negative, that were not expected. We discuss this further in the conclusion.

4. DESIGN AND IMPLEMENTATION OF THE CROSS-FUNCTIONAL COURSE PROJECT

The cross-functional course-project was implemented in the spring of 2015 with the following PBL elements, shown in Table 1.

PBL Element	Implementation
Unstructured nature of the task and problem	Students were required to drive their own projects – everything from picking the topic to communication strategies to design of deliverables (e.g., modeling notation). A basic timeline for the semester with a few deliverables was outlined to keep students on track, but otherwise the teams needed to define, organize, and complete the project and solve the problem at hand utilizing their own strategies and working as a team.
Holistic learning outcomes	Students were challenged with the presence of individuals with various roles, different expectations, and diverse backgrounds all on one team. In addition to completing the project, they were tasked with bringing a diverse group together to complete a goal, which presented many obstacles to their success. Students were permitted to provide input on team formation, but final team formation was conducted by the faculty team.
Consultative role of the teacher	Faculty were available to answer questions for any student from any student involved, and the faculty coordinated amongst themselves to assure they were acting as consultants and monitor the extent to which teams reached out.
Active role of the student	With multiple sources of motivation, students were driven to take an active role in the completion of the course project. Further, students were given an opportunity to provide feedback on each of their team members at specific points during the semester. This was utilized to discourage inactive or loafing team members.
Collaboration and interaction among students and teachers	Students were placed in cross-functional teams, and the task was simply too large for any one person to complete on his or her own. Further, specific roles for the accounting and IS students were discussed with the students so that they would feel confident in their ability to contribute to the team and interact with others. Student-teacher interaction was extensive as time was dedicated to meeting during class sessions, in office hours, and on-demand.
Focus on real-world and cross-disciplinary problems	While a list of potential topics was provided, the list was largely developed by a member of the faculty team with extensive industry experience and the PICPA was only willing to accept submissions of business applications that solved real-world problems.

Table 1. Illustration of PBL Components of the Course Project

The professors teaching the capstone courses in accounting and IS met prior to the start of the semester to structure and scope the student projects. In a single organizing /project launch during the first week of classes, 150 accounting and IS students (5 were double majors) were distributed into 28 teams of approximately five students each. To make this more manageable, one IS instructor was paired with one accounting instructor, and this pair formed 14 groups across their two classes. This method of forming the teams was selected so that the instructor pairs could visit each other's classes if needed, rather than requiring all four instructors to go to four classes.

Each team was charged with creating a web application that focused on an accounting, financial reporting or auditing topic. The teams were cross-functional, consisting principally of two to three accounting students and equal number of IS students. Student teams had the opportunity to choose a topic from a suggested list of topics or develop their own related topic. Most of the topics chosen for the projects focused on the following areas in auditing: segregation of duties; determination of auditor independence; inventory obsolescence; establishment of lower of cost or market for inventory; calculation of ratios and analysis to identify "red flags" in an audit of financial statements; and determination of whether to consolidate or use the equity method for financial statement consolidation. The student groups who chose their own topics focused on areas of audit efficiency and accuracy.

To evaluate the teamwork, the instructors utilize the CATME Smarter Teamwork system to periodically check in to see how the teams were working together (Ohland et al., 2012). This system can generate flags to mark certain types of behavior that might be occurring in a group based on the students' responses. Students can also view their peer feedback, compare it to their self-evaluation, and then attempt to improve their teamwork skills.

For classroom purposes, the task presented to the students was structured similar to a consulting project. The accounting students served as both the client and the content experts, identifying a particular accounting or auditing need and proposing that an app could address the particular need. The accounting students also supplied the detailed technical knowledge of the focus area and provided feedback regarding the final design and finished product. The IS students gained an understanding of the client's need by interviewing the accounting students and asking questions about the topic area and the requirements of the application. The IS students then proposed a design to the client, developed the app to the specified design, and prepared the applicable documentation.

Specifically, development of the application required the following analysis, design, development and implementation activities:

- Documentation of current state vs. future state processes in standard modeling notation
- Design of interfaces with a focus on the end user
- Modeling and implementing databases to support the app
- Development of web-based applications in ASP.NET with Visual Basic, using Microsoft Visual Studio as the development environment
- Publishing the app to Microsoft Azure, a cloud-based platform that hosted the app and database

Final testing of the app was conducted by all members of the team to ensure the overall objectives were achieved. At the end of the semester, each team was required to make a formal presentation to a panel of faculty members and external judges, as well as a peer teams. The teams were evaluated on the functionality of the app, its usability, overall design, and accuracy. Throughout the semester, teams had the opportunity to interact with teams examining a similar app topic during class, which created a natural audience for ideas and feedback generation.

Overall, the IS courses, given the nature of their task, dedicated a larger portion of the course to completing the course project. On the other hand, the accounting courses dedicated a smaller portion given their role in formulating the problem for the IS students. In retrospect, this was one of the weaknesses of the project design as the students very quickly noticed the inequity, which created tension on some teams. However, this is also representative of real work project teams as different team members can have different priority levels for the project at hand. To attempt to alleviate tension, instructors made themselves

available to any students from either section so that issues could be discussed and addressed.

5. IMPACT ON STUDENT LEARNING

The learning outcomes, and therefore the impact on student learning, were significantly dependent on the students' role in the project. For the accounting students, application development and performing the role of a client were new areas, and thus the primary assessment question focused on the extent to which their role helped to reinforce and augment their accounting knowledge. To answer that question, pre- and post-project quizzes were administered to the accounting students to determine their base level of knowledge prior to starting the project, and then to assess their level of knowledge after the project was complete. The quizzes included questions about apps in general as well as auditing and business topics. The results of the post-quiz showed an 18% increase when compared to the pre-quiz, with significant improvements in areas such as inventory valuation (64% increase), audit quality (57% increase) and identifying red flags during an audit (36%). Other factors that could have impacted the students' learning, such as assignments in the mentioned or other classes, were not controlled. While we are unable to conclude that the increase in learning was directly attributable to the completion of the app project, it certainly was a contributing factor.

Grading Rubric Items (measured on 5-point scale)
• Document client's webapp requirements • Document client's data requirements • Document as-is or current state processes in diagrams (e.g. DFDs, use case) • Document to-be or future state processes in diagrams (e.g. DFDs, use case) • Design appropriate database based on requirements • Design appropriate screens, forms, and reports based on requirements • Document/explain how the design is fulfilling the specified webapp requirements • Create database in MS SQL Server in Azure • Develop screens, forms, and reports based on design • Demonstrate and explain the application to the client • Completion of project

Table 2. Grading Rubric

For the IS students, the learning outcomes and impact were directly attributable to the accuracy of the process and data models, the quality and usability of the applications developed, and the extent to which the applications addressed the accounting need. A grading rubric (see Table 2) was utilized by the faculty members, external judges and the student peers to ensure consistency in evaluating the applications developed. Of the 28 teams, 26 teams completed business applications that earned an average of satisfactory or above (3 out of 5) on the rubric. The two teams that did not achieve this metric either did not finish core functionality or the functional incorporated lacked basic usability.

On an affirmative note, the apps were submitted to the PICPA for the independent evaluating and judging. Our student teams placed first, second and third, with the first place team having designed an app to assist with understanding segregation of duties.

6. CONCLUSIONS

Based on the learning assessments, problem-based learning was effective in promoting student learning. The students themselves generally agreed with this assessment, in that their feedback on the project was generally positive. Notably, students indicated that they were able to see the connection between classroom learning and actual implementation, which was a key learning objective of the capstone courses. This made the experience more relevant to the students, and as such they were more motivated to participate actively in their own learning. Overall, utilizing this approach was an innovative way for students to apply knowledge from their previous courses as well as integrate newly learned concepts.

With regard to lessons learned and a 'word to the wise' to others who might wish to use this approach, we should note that significant time was required of faculty members for the project, especially in the early stages and for the IS faculty during the app coding stage. In a problem-based learning approach, the model of faculty as facilitators/mentors is in many ways more challenging than a more 'traditional' approach. The students themselves were surprised at the time required to bring everyone on a team to at least a similar level of knowledge in order to begin the project.

Finally, and in a broader sense, the learning was about more than the technical knowledge of information systems and accounting gained from the experience. Students also learned valuable

'soft skills', including communication, overcoming the challenges of working in cross-functional teams, and time management in the context of a complex project with multiple deliverables, uncompromising time deadlines, and a real-world client who is expecting a solution to a real problem, as other studies have suggested (Russell, Russell, & Tastle, 2005).

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