Building I.S. Professionals through a Real-World Client Project in a Database Application Development Course

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Abstract

Information systems curricula are increasingly using active learning methodologies to help students learn *through* technology rather than just *about* technology. While one way to achieve this is through the assignment of semester-long projects, previous research suggests that real-world projects provide more meaningful experiences and prepare expected graduates for careers that will rely on both their technical and professional skills. Additionally, providing opportunities for both competition and collaboration spur the motivation of students while enabling them to practice the necessary professional skills employers are seeking. This paper reports on a database application development course, taught for the past four years, where the instructor has partnered with a different community business or nonprofit organization in need of an information system to convert existing spreadsheet data into a relational database for more accurate data entry and improved reporting. Student teams engage in both competition and collaboration through system development phases to deliver a database solution to an authentic client using Microsoft Access. As a result, students develop both technical and professional skills through this client project experience where ultimately, the client evaluates the students' performance.

Keywords: database, real-world, collaboration, competition, experiential learning, Microsoft Access

1. INTRODUCTION

Higher education institutions are evolving to create more relevant, meaningful experiences for its students through the use of real-world projects in the curriculum. The days of "chalk and talk" and "sage on the stage" are slowly being replaced by teaching methods that involve active and experiential learning by students. Incorporating real-world projects into the information systems curriculum is not unfamiliar territory and is common to help bridge the gap between theory and practice. Students who major in technical fields need to learn not only the concepts and techniques, but also need to gain real-world experience before joining the workforce (Chuang & Chen, 2013). While information systems curricula have been successful in preparing students with technical ability, a 2014 study by the Society for Human Resource Management found that the top four applied skill gaps in technical occupations were critical thinking/problem solving (39%), professionalism/work ethic (34%), leadership (30%), and written communication (25%) (2014). In order to better prepare students for the technical and the professional, a real-world client project was used within the context of a database application development course for upper-level information systems (I.S.) students. Partnerships between the business world and higher education have the potential to provide

numerous opportunities (Abbassi & King, 2007). For the organization, it provides fresh perspectives from both faculty and students in addition to a deliverable that increases the value of the organization. For the higher education institution, students are exposed to practical, authentic situations prior to graduation. Additionally, the institution benefits from increased exposure and standing in the community.

Since 2012, a faculty member from the I.S. department within the business school contacted community non-profit organizations and small businesses. Through these relationships, relevant business needs were translated to an opportunity to develop a database information system for the organization. To date, the organizations served have included a domestic violence and community outreach non-profit, an early childhood education center, a private law practice, and the local homeless continuum of care consortia. Through this course, systems that manage volunteer statistics for state reporting requirements, donor engagement, debt collections, and homeless reporting for the Department of Housing and Urban Development, have all been developed and implemented. At the beginning of the semester, the class begins with requirements gathering and progresses through stages of conceptual modeling, physical design, testing, feedback, and implementation, which occurs after the course is complete. The course culminates with students presenting their database application, built in Microsoft Access, to the client for additional feedback and acceptance.

This concept of integrating theory and practice into the classroom, at Millikin University in Decatur, Illinois, is coined as Performance Learning. As defined by the institution, it is the opportunity for students to experience real risk and reward while having their work evaluated by a third-party stakeholder (Figure 1). The third-party stakeholder, or client, has measurable weight in not only evaluating/grading the student deliverables, but in the use of the application developed. Not only are students engaged in practicing their discipline, reflection is intentionally built in during and after the experience.

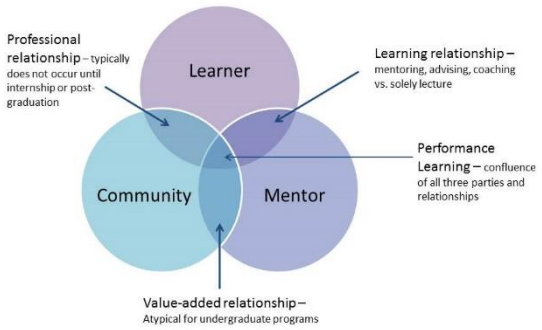

Figure 1.

This paper first reviews previous research related to real-world project use in the classroom and its relationship to higher-order thinking and problem solving that supports the institutional definition of Performance Learning. A detailed account of the course design is outlined and the paper concludes with summative results from student and client feedback over the past four years and its relationship to the practicing of both technical and non-technical skills. This work is important to the discipline in demonstrating that the experience of working for a client with true business needs and goals, where risk and reward are present, provides for increased student engagement, satisfaction, and deeper learning of course content.

2. REVIEW OF LITERATURE

A contemporary issue in I.S. education is how best to incorporate active learning in the classroom to better prepare students for careers following graduation. Student are able to gain real world experience through internships and faculty-directed research projects, but this typically only affects a small number of students. In order to reach a broader audience, curricula have slowly shifted from more lecture-based learning to a style that engages students in a more applied fashion through project-based work, and the I.S. discipline lends itself well to this method. Schuldt (1991) defined these as "simulated projects" and "real world" projects (p. 35). Some instructors create projects that simulate business operations and students are required to perform analysis, design, and creation of an information system. Others have engaged with a community business or organization that have an actual problem that needs solved with the creation of an information system. These are typically non-profit organizations without the experience or expertise to create a database information system (Schuldt, 1991). Others have partnered with local

chambers of commerce and used service learning models in real world information systems projects (Chuang & Chen, 2013). Previous research has shown that students prefer and benefit from real-world projects with authentic clients over simulated projects (Connolly & Begg, 2006).

Through the use real-world projects in the classroom, students gain experience in actual I.T. work before graduation and are able to apply the classroom technical concepts. This helps students gain a more realistic understanding of information systems and solve real I.T. issues (Abbassi & King, 2007). Given that the pace of technology advancement continues to increase, "it is important that educators link the classroom learning to the practice in real-world settings where the classroom models can be tested; and the problem solving and critical thinking skills can be practiced (Chuang & Chen, 2013). Applying constructivist learning theories are well suited for I.S. education. In constructivism, the learner builds on his and others' prior knowledge, belief, and actions. Since technological knowledge is created rather than discovered, learning can happen "naturally" through manipulation (e.g. trial and error) (Connolly & Begg, 2006; Tétard & Patokorpi, 2005). Real-world projects allow students to solve problems in a non-prescriptive context. The constructivist approach to project-based learning in I.S. has yielded affirming results that both domain-specific and social skills were the most valuable throughout the course (Tynjälä, Pirhonen, Vartianen, & Helle, 2009).

While other I.S. educators have proved real-world projects effective, teams of students can benefit from both competitive and collaborative environments. In collaborative learning environments, students assist each other in learning the course material while developing oral and written communication skills, and provide the opportunity to improve their leadership skills (Dietrich & Urban, 1996). Injecting competition, as is the case in the data modeling phase of this real-world project, increased productivity, decreased inefficiency, and motivated students to find the best solution. Not only did students understand the "value of collaboration that is required for effective team performance and true problem solving" (Desai, Tippins, & Arbaugh, 2014, p. 260), but were highly motivated when faced with this moderately competitive element.

Employers are not only seeking graduates with the technical acumen to help the organization, but employers are seeking graduates with a broader set of soft skills. According to a survey conducted from August through early October 2014, by the National Association of Colleges and Employers (NACE), the skills most sought after are teamwork, and ability to make decisions and solve problems. The next most important skill was the ability to communicate verbally with people inside and outside the organization (Adams, 2014). The top 10 skills from the NACE survey can be found in Table 1, in order of importance. Ultimately, providing students with opportunities to practice these sought after skills in real-world environments better prepares them for the workforce.

Top 10 Skills Employers Seek
1. Ability to work in a team structure
2. Ability to make decisions and solve problems (tie)
3. Ability to communicate verbally with people inside and outside the organization
4. Ability to plan, organize, and prioritize work
5. Ability to obtain and process information
6. Ability to analyze quantitative data
7. Technical knowledge related to the job
8. Proficiency with computer software programs
9. Ability to create and/or edit written reports
10. Ability to sell and influence others

Table 3.

Therefore, based on the use of real-world projects in an I.S. course, can technical and professional skills be built simultaneously through competitive and collaborative learning?

3. COURSE DESIGN

The course, database application development, is required for the I.S. major housed within the business school. Students in the I.S. program are grounded in the theoretical areas of programming, system analysis/design, relational databases, and networks while learning hands-on skills in both business and technology that prepare them for managing applications, data, networks, and systems in a wide variety of organizations. This course introduces concepts of relational database theory, data modeling, normalization, and database design principles while building technical skills such as: structured query language (SQL), transaction management, security, and database administration. This course provides students with hands-on experience in translating conceptual data models to physical design through Microsoft Access, MySQL and Oracle database software packages.

Students in the course are typically juniors or seniors who have already had at least one programming course as well as an information technology infrastructure course.

While students are engaged in learning the course content and practicing their technical skills through specific lab assignments, teams of students are immersed in building a database application centered on a specific client's needs to solve a real business problem. Students are placed into teams of 3 or 4 and are determined by students completing a self-assessment of both their technical and interpersonal skills. The instructor uses this information to weight the teams fairly given individuals' strengths and weaknesses. On average, the course enrollment is between 9 and 12 students. The client project is divided into stages of: data modeling, physical database design and report development, user interface, testing & documentation, and presentation & acceptance. This traditional development cycle allows for student teams to present multiple times to the client throughout the semester. As a result, the client feedback becomes the anchor throughout the entire project. The final product at the end of the semester is then implemented and maintained by a paid student intern from the course during the following semester. Students apply for the paid internship towards the end of the fall semester and go through an interview process with both the instructor and the client. A visual of the course design can be found below in Figure 2.

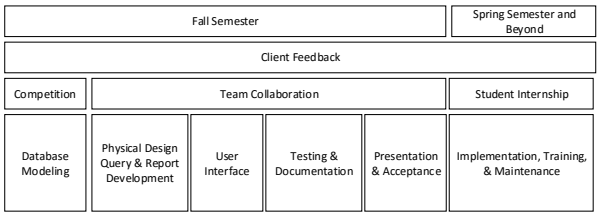

Figure 2.

Initially, the instructor and the students meet with the client at their place of business during the second week of class. Meeting onsite allows for students to tour the facility, understand the role of the organization, and see the larger purpose of their work. During this site visit, students meet the individuals with whom they'll be working. This typically includes a front-line person who currently manages information manually or through a spreadsheet application. Additionally, a supervisor or director is included to help guide the overall strategy of the project. This initial meeting is also the opportunity for the client to explain their current information system, its problems and inefficiencies, and what their vision is for a new information system. Through this process, students are able to understand the existing business process, data elements, and business rules. After the initial client meeting, designated liaisons from each team maintain contact with the client through phone and email to ask additional questions and seek clarification. Teams then work independently to prepare a problem statement that is used to guide the business rules for developing a conceptual data model. The problem statement also serves as the scope of work for the project that is mutually agreed upon by the client and the instructor.

A unique element of this course is the incorporation of competition between the teams during the conceptual data model phase of the project. During this phase, each team is tasked with developing their own conceptual and entity-relationship data model using Microsoft Visio based on their approved problem statement that outlines the business rules and data requirements for the client. Each team presents their data model to the instructor and to the client. Students are instructed to "teach" their data model in the context of their problem statement to the client and instructor. This approach helps to reinforce the fundamentals of data modeling and also educates the client on the fundamental structure of their database information system. After the teams present, the instructor meets with the client to receive feedback and assess the quality of each data model. The client and instructor collectively determine a "best data model" award. With feedback and suggested changes, the project moves forward using the "best data model" as the only data model used for the remainder of the project.

Following the data modeling phase, teams are tasked with implementing the physical data model into Microsoft Access. While there are other DBMS products that are more robust than Microsoft Access, the needs of the clients typically do not exceed the limitations of Microsoft's desktop-based database software package. Microsoft Access is the next evolution in data management from a spreadsheet application, offers a wide range of capabilities, and allows for a rapid application development cycle (Chung, n.d.). In addition, cost is usually a concern when discussing the software environment with non-profit organizations and small businesses. Microsoft Access is a low-cost software product (approximately $110 per license as of January,

2016) in comparison to larger platforms such as Microsoft SQL Server or Oracle, which require a server infrastructure. Based on the clients that are typically selected for this project, Microsoft Access elevates their information system to the next level, and as Chung asserts (n.d.), the "vast majority of database solutions are simple" and Microsoft's desktop application provides a rapid application development (RAD) environment to improve business processes.

From this point forward, teams are allowed and encouraged to collaborate with each other through the report and user interface design phases, as well as testing and documenting. Through these phases, report and user interface deliverables are divided across the teams to complete and incorporate into the final product. Using this approach was preferred over having each team complete their own version of the database application, as there would be duplication of effort. This approach was also preferred to having each team responsible for a different phase as students would not be able to practice their skills in all of the areas of data modeling, SQL, and interface design. However, students did cite difficulty in combining work into one Microsoft Access file despite attempts at various version control systems. As part of the final deliverable, the client receives a print and electronic copy of end-user and technical documentation. Typically, a member of each team collaborates to combine, review, and standardize the documentation. At the end of each of these development phases, students again present their work in a professional setting to the client for formal written and verbal feedback. The final presentation is a collaborative effort between all teams to showcase the final version of the database application to the client in addition to outside evaluators from the university and technology community. Following the presentation, students complete a team and self-evaluation that is used for both reflection and evaluation of their work. Per Kolb's definition of experiential learning, students were provided a concrete experience (real-world client project), abstract conceptualization (data modeling), active experimentation (application development), and reflection (self-evaluation) (1984).

As Abbassi and King noted, "real-life business projects are not automatically declared complete at the end of the semester" (p. 341, 2007). Following the final presentation, the client invites students from the class to apply for a paid internship, supervised by the client and the instructor, the following semester to resolve known issues as well as lead implementation and training efforts for the client. In the end, students have built a technology solution from conception to implementation and community organizations have benefited from the collaboration.

5. RESULTS

After students have delivered their final presentation, the client is asked to complete an evaluation of the students' work. The client is asked questions about what was done best, what needs improvement, and if the organization benefited from the partnership. Over the four years the course has been offered in this format, each client specifically commented on the students' ability to listen to their business needs, ask appropriate questions, and carefully seek create solutions to solve their problem with user-friendly applications. One client representative said this about the students' work:

> "The entire group listened to our needs and adapted the model to meet those needs… I was impressed with the attitude and professionalism shown by each of the students. I always felt like they were eager to work on this project and that it was important to them."

Clients' comments related to improvements were mostly application specific and related to design of the user interface. One client commented that the students relied on the end of the course and the impending intern as a crutch for unresolved issues. All clients expressed resounding support for the partnership and were eager to pursue a partnership with a class again when an opportunity arose.

Student self-evaluations were analyzed qualitatively for specific mention of skills practiced in the areas of database, collaboration, and professional communication. Individual student self-evaluations were required as part of the project. Students were asked to reflect on their experience, and describe how they contributed to the overall success of the project and what skills they applied throughout the semester. Although 45 students have taken the course over the past four years, only the last 3 years of self-evaluations were analyzed (36 students) as the first year of the course used a self-evaluation instrument that did not address these skills. Students reported specifically

practicing and building database skills (81%), collaboration (81%), and professional communication (64%). Although this is a small sample size due to the enrollment and size of the program, it represents a compelling case that both technical and professional skills are being built as a result of this client project methodology.

6. DISCUSSION AND CONCLUSIONS

The class is successful, in part, due to the relationship between the university, faculty, and the client. Managing the relationship can be time consuming for the instructor and students, but is paramount in stewarding the project from beginning to end. As has been identified in previous work, one major challenge is working with users who can clearly define the problem. (Schuldt, 1991). As a result, managing the scope or changing definitions of the scope have occurred. Better problem definitions have come from users with more technical experience.

To date, there have not been any failed implementations of the applications built by students, but it remains a real risk for students and the faculty. It is important to select clients carefully, understanding the scope and complexity of their needs far in advance of the beginning of the semester. Serious conversations need to take place with the client so that they understand the timeline for development and implementation, which is likely to be longer than that of a full-time and full-service consulting firm. The client also needs to have a realistic expectation of the skill level of the students. Having students understand the meaning and importance of their work is equally important in driving their motivation to be successful in delivering the final product.

However, the challenges in integrating a real-world project into the classroom are not unlike the challenges of building an information system in practice as a professional. Additional time should be allocated by the instructor to maintain contact with the client and to work outside of normal class hours assisting student teams to solve unforeseen issues. One ongoing concern remains for the integration of real-world projects across the I.S. curriculum. Students enrolled in multiple I.S. courses that contain real-world projects may be too time intensive for some students.

Because student projects are in production use at client sites, ongoing maintenance beyond the initial student internship is a challenge that is being overcome. Work is in progress to launch a student-run consulting venture to maintain software, manage client relationships, technical documentation, and knowledge transfer as students graduate. These steps will help to ensure the sustainability of these client projects.

Ultimately, students are confronted with an array of conditions and variables in a real-world project, whereas a simulated project insulates them from uncertainty, conflict, and change. A real-world project places students in situations where real risk is involved, not unlike the professional arena where they will soon be. Real-world projects take the focus off the grade and the course, and instead, place the emphasis on performing their craft as I.S. professionals, as they will be upon starting their first job. The results of this research support that this experience provides students with the opportunity to complement their technical acumen with employer-desired "soft" skills such as team collaboration and professional communication. In the future, the course will continue to evolve as new projects are completed for clients in the community. Further research is necessary to assess the impact the course has made after graduation and how this course has played a part in their development as I.S. professionals.

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