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Can IT Prototyping Enhance Business School Education?

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Abstract

In business school, students must learn essential communication, analytical, and problem-solving skills. In this study, we examine whether the prototyping project in our computer-based information system (CBIS) course enhances these three essential skills. The prototyping process, taught with an information system approach, is the focus of our project-centered teaching method. The pedagogy uses a system development life cycle model to define problems and to analyze, design, and develop computer systems. A questionnaire administered to 184 students who had taken the course suggests that the CBIS course improves communication skills and problem-solving skills than on analytical skills. The prototyping project does not enhance analytical skills, but does significantly enhance communication skills and problem-solving skills. These findings can help to improve the teaching of CBIS to business school students.

Keywords: Computer-based information system, Prototyping, Communication skills, Analytical skills, Problem-solving skills

Introduction

In their book "Higher Education of Business," Gordon and Howell (1959) emphasized that business schools in higher education should provide better quality education than provisional schools. What are the educational goals that lead to high quality business education? The goals of our undergraduate programs are to teach students (i) effective business communication skills; (ii) effective analytical skills that support decision-making; (iii) the ability to integrate business knowledge and to solve problems in a business environment; (iv) the ability to propose strategies in a global environment; (v) awareness of ethical issues in a business context; and (vi) specific knowledge in one or more functional areas of business management.

A school's educational goals should lead to graduate employability. Kavanagh and Drennan, (2008) pointed out that employers expect their employees to have excellent communication, analytical, professional, business-awareness, and teamwork skills. Andrews and Higson (2008) suggested that employers want business school students to have hard business-related knowledge and skills; soft business-related skills; and work experience and work-based learning. Alternatively, these can be called analytical skills, communication skills, and problem-solving skills, respectively. If we match the goals of our undergraduate programs with the skills that lead to graduate employability, we can see that soft business-related skills (communication skills) are related to (i) effective business communication skills and (iv) the ability to propose strategies in a global environment. In contrast, business specific issues such as hard business-related knowledge and skills (analytical skills) are attained though (ii) effective analytical skills for decision-making and (vi) specific knowledge in one or more functional areas of business management. Similarly, work experience and work-based learning (problem-solving skills) are derived from (iii) the ability to integrate business knowledge and solve problems in a business environment, and (v) the awareness of ethical issues in a business context. Figure 1 presents a model of these relationships.

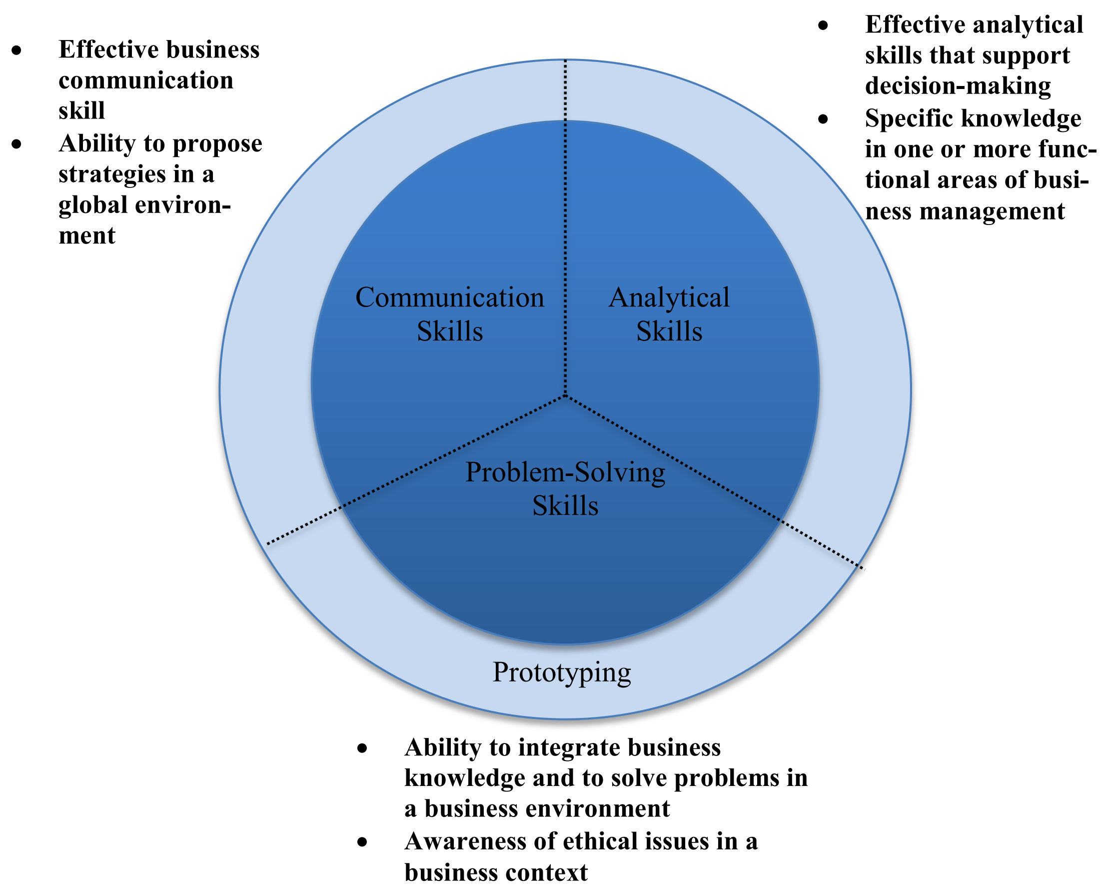

Figure 1 Mapping employability skills with education goals in a business school.

A computer-based information system course (CBIS) that teaches computers, information technology, and software development to students is a required, but not always popular, subject in business schools. Conventional subject-oriented approaches designed for computer engineering students do not fit the needs and interests of business school students. Our experience has shown that a project-centered teaching approach is effective for teaching IT knowledge to business school students (Wong & Du, 2003). The approach asks students to identify and solve a real-world IT problem and uses the project to encourage active involvement in the whole learning process. Our 14-week computer-based information system course adopts a system development life cycle model with 10 phases. As the students have a self-chosen real-world project to focus on, they are eager to learn the skills that can help them to solve their problems. This approach changes the conventional one-way lecturing relationship between teacher and students, and the instructor becomes both a teacher and a mentor. It can be considered another way of flipping a class. The grading scheme includes a group-based laboratory test, group-based in-class assignment, investigation report, project proposal, project presentation, final documentation, and final examination. Moreover, as we argue in this study, a well-designed project-centered CBIS course may also effectively enhance students' communication, analytical, and problem-solving skills.

In project-centered teaching, resource limitations and time constraints usually mean that even real-world projects normally end with the presentation of a prototype. Building a prototype gives students a systematic way of integrating knowledge from investigation, system analysis, system design, and system development. A successful prototype requires communication, analytical, and problem-solving skills. In this study, we examine whether building a prototype teaches these three skills. Specifically, we examine whether prototyping a Web-based information system enhances a student's ability to propose strategies in a global environment (communication skills); to learn specific knowledge in one or more functional areas of business management (analytical skills); and to increase their awareness of ethical issues in a business context (problem-solving skills).

Related Works

The conventional pedagogy in Asian schools emphasizes analytical skills, partly because the results can be relatively easily measured. Although the new trend in business school education is to emphasize soft skills, hard business knowledge and training are still the foundation that employees need to carry out their jobs. Thus, it is vital that a CBIS course offered to business school student teaches analytical skills.

Barrett (2006) found that a manager spends about 70 to 90 percent of his or her time every day in communication. Communication skills are the most important skills a manager must possess. Senior executives who want to be effective leaders need communication skills more than any other skill. That is, the ability to communicate with others is one of the most important skills to teach business school students (Milam and Martin, 1994). Experiential modes of learning are suitable for teaching skills such as networking skills or leadership (Whitley, 1989). These skills are difficult to teach in conventional classrooms, especially as faculty members are often hired because of their strong theoretical and analytical skills (Pferffer and Fong, 2002). Project teams can provide experiential modes of learning that teach students about internal communication with team members and external communication with clients. Communication in teams formed of people who complement each other can improve productivity (Scarfino and Roever, 2009). Martins and Kellermanns (2004) used Web-based technology to free up class time for students to work on interpersonal and communication skills. However, to help students acquire knowledge about system development, face-to-face learning is necessary, as pure online instruction is insufficient for teaching analytical skills (Santos & Wright, 2001).

Uncertainty, difficulties, or even assignments and tasks are part of ordinary workdays. We may encounter problems at any moment. Educators agree that equipping business school students with good problem-solving skills is crucially important, as strong problem-solving skills can improve careers. Many sources have made suggestions for improving students' problem-solving skills. For example, case study approaches enable students to develop both analytical and problem-solving skills (Gibb, 1996). Bigelow (2004) used a 7-step problem-based learning model to help students acquire problem-solving skills and basic knowledge.

It has been shown that a CBIS course can enhance essential skills. For example, Aesaert and Braak (2014) found that pupils' ICT self-efficacy positively influenced their analytical intelligence, control learning style, and amotivation. Amotivation is caused by feelings of incompetence and a lack of control (Vallerand, 1992). Wang, et al. (2014) discovered that some types of social network sites (SNS) have a positive effect on users' well-being, but do not improve the quality of friendship among college students. Lin, et al. (2014) analyzed Facebook emotional disclosure and found that users with denser networks disclosed more positive and negative emotions, although the amount of disclosure was also mediated by the need for emotional expression.

The system development life cycle includes five phases: system planning, system analysis, system design, system implementation, and system support. In classrooms, due to limited resources, time, and programing skills, it is not feasible to provide training in the last two phases. Thus, in a class project students are normally expected to develop a prototype, but not to implement a real system and provide support for it. In the system development cycle, the crucial steps of system design are developing source documents, layouts for system users for inputs and output, and database management (Whitten & Bentley, 2005). Prototyping is an essential step between system design and development that converts concepts into a system. Budde et al. (2011) considered prototyping an evolutionary system development approach for constructing and evaluating models. Many systems developed from new concepts rely on prototyping. For example, Ahsan, McManis, and Hashmi (2014) built a prototype for intelligent vehicle speed monitoring and management. Argoty and Figueroa (2014) developed a prototype for an interactive hospital room with natural interaction devices. Ayer, Messner, and Anumba (2014) presented a workflow model for a mobile computer-based prototype for architectural engineering students. According to the Merriam-Webster dictionary, a prototype is a full-scale of model or example that exhibits the essential features of a design. Modeling and providing examples are the results of system analysis and this demands analytical skills. Exhibition, however, is a form of communication that requires communication skills. Finally, problem-solving skills are needed to derive a model's essential features though complete system planning, analysis, and design. As a result, prototyping is a skill that integrates many indispensible business skills.

Research Method

Andrews and Higson (2008) argued that business schools should provide students with three major skills for graduate employability: interpersonal and communication skills, analytical skills, and problem-solving skills. Extending our previous study of project-centered teaching (Wong & Du, 2003), we designed a CBIS course based on real-world group projects that contained the following 10 phases: form a team, solicit clients (each group uses their own personal network to find a client from the business world), research the project, conduct group meetings, design a database, organize a lab test to drive the system analysis, work on in-class assignments, review project with instructors, present project, and arrange a Q&A session for peers after the project presentation. We asked students to identify which phases were most helpful in developing specific skills. Tables 1 to 3 list the items (phases) measured on a 5-point Likert scale, ranging from "most helpful" (1) to "least helpful" (5).

Table 1 Items for measuring communication skills

A	Effective business communication skills
A1	Forming a BIG group (8-10 persons)
A2	Communicating with your client
A3	Doing research for your project
A4	Group meeting
A5	Lab test
A6	In-class assignment
A7	Project review
A8	Project presentation
A9	Q&A on the project presentation

Table 2 Items for measuring analytical skills

B	Effective analytical skills that support decision-making
B1	Studying the daily operation of your client's company
B2	Creating a database
B3	Doing research for your project
B4	Communicating with your client
B5	Group meeting
B6	Lab test
B7	In-class assignment
B8	Project review
B9	Project presentation
B10	Q&A on the project presentation

Table 3 Items for measuring hard business knowledge and problem-solving skills

C	Increase your ability to integrate business knowledge and solve problems in a business environment
C1	Communicating with your client
C2	Preparing your investigation report
C3	Creating a database
C4	Doing research for your project
C5	Group meeting
C6	Lab test
C7	In-class assignment
C8	Project review
C9	Project presentation
C10	Q&A on the project presentation

As discussed, prototyping is a systematic method for enhancing communication, analytical, and problem-solving skills. To verify the success of prototyping as a teaching method, students were asked which of the following 10 steps helped them to improve their advanced communication, analytical, and problem-solving skills: system investigation process, system analysis, system design, doing research, group meeting, lab test, in-class assignment, project review, project presentation, and Q/A in the project presentation. The items used in the survey are shown in Tables 4 to 6.

Table 4 Items for measuring advanced communication skills.

D	Building a prototype to increase your ability to propose strategies in a global environment
D1	System investigation process
D2	System analysis
D3	System design
D4	Doing research for your project
D5	Group meeting
D6	Lab test
D7	In-class assignment
D8	Project review
D9	Project presentation
D10	Q&A on the project presentation

Table 5 Items for measuring advanced problem-solving skills.

E	Building a prototype to increase your awareness of ethical issues in a business context
E1	System investigation process
E2	System analysis
E3	System design
E4	Doing research for your project
E5	Group meeting
E6	Lab test
E7	In-class assignment
E8	Project review
E9	Project presentation
E10	Q&A on the project presentation

Table 6 Items for measuring advanced analytical skills.

F	Building a prototype to learn specific knowledge in one or more functional areas of business management
F1	System investigation process
F2	System analysis
F3	System design
F4	Doing research for your project
F5	Group meeting
F6	Lab test
F7	In-class assignment
F8	Project review
F9	Project presentation
F10	Q&A on the project presentation

Data Analysis

The sample consists of undergraduate students who completed the Information Systems and E-Commerce course at a respected university in the 2011/2012 academic year. The course is a required course offered to business school students in the integrated business administration curriculum. Out of 196 returned forms, 9 were missing one item, 2 were missing the answers on the second page, and 1 had no student ID, leaving 184 valid questionnaires. The average scores of the six constructs (see Tables 1 – 6) are shown in Table 7.

Table 7 Average scores of the six skills constructs.

Construct	A	B	C	D	E	F
Avg.	2.1202	2.2057	2.1491	2.2372	2.5903	2.1578
Rank	1	4	2	5	6	3

We first investigate whether there is a difference between the constructs, i.e., H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6$. The one-way ANOVA result (F Value at 72.31 and Pr<2e-16) indicates this hypothesis is rejected.

Next, we use the Welch Two Sample t-test to compare the differences between the three basic skills. Note that the scale ranges from 1, "very helpful," to 5, "least helpful." The results show that students think the CBIS course improves their communication, analytical, and problem-solving skills (2.1202, 2.2057, 2.1291, respectively), but, as the averages are close to 2.5, or neutral, they do not think the course makes large improvements in these skills. We compare the constructs A and B; B and C; and A and C. The results reject the hypothesis H_0 that there is no difference between A and B (t = -2.9059, d.f. = 3670.542, and p-value = 0.001842); fails to reject the hypothesis H_0 that there is no difference between A and C at the 99% confidence level (t = -0.985, d.f. = 3659.767, and p-value = 0.1623); and rejects the hypothesis H_0 that there is no difference between B and C (t = -2.0026, df = 3915.412, and p-value = 0.02264). This indicates that the course has more effect on communication skills and problem-solving skills than on analytical skills.

Next, we use the Welch Two Sample t-test to compare the differences between the three basic skills and the advanced skills. That is, we compare A and D; B and F; and C and E. The results reject the hypothesis H_0 that there is no difference between A and D (t = -4.0009, d.f. = 3656.949, and p-value = 3.217e-05); fail to reject the hypothesis H_0 that there is no difference between B and F at the 99% confidence level (t = -1.6492, d.f. = 3908.819, and p-value = 0.04959); and reject the hypothesis H_0 that there is no difference between C and E (t = -15.0013, d.f. = 3888.353, and p-value < 2.2e-16). These findings suggest that the CBIS course has more effect on construct A (communication skills) and construct C (problem-solving skills) than on construct B (analytical skills). However, prototyping does not further enhance communication skills (from 2.1202 to 2.2372) or problem-solving skills (2.1491 to 2.5903). Moreover, we cannot prove it enhances analytical skills (2.2057 and 2.1578).

Building a prototype is the last step in the class and is approached from a system perspective. Thus, it is fair to examine only the first three items used to measure constructs D, E, and F to see how building a prototype helps to teach communication, analytical, and problem-solving skills. The data show an average of 2.13, 2.54, and 2.00 for constructs D, E, and F, respectively. Therefore, we separate those items dedicated for system prototyping, i.e. D1, D2, and D3 in construct D, from the rest of items to estimate the loadings of path coefficients between construct A and D' (a new construct without D1, and D2, and D3), between P (a new construct includes D1, D2, and D3) and A, and between P and D' using linear structural relations (LISREL). We found that the estimation between P and A is 0.474 (t = 6.342), between P and D' is 0.273 (t = 3.342), and between A and D' is 0.603 (t = 4.118). The fit indices AGFI = 0.84, RMSEA = 0.06, and Bentler comparative Fit = 0.97 show a good fit. This confirms the IT prototyping can enhance communication skills.

Similarly, we separate those items dedicated for system prototyping, i.e. E1, E2, and E3 in construct E, to estimate the loadings of path coefficients between construct C and E', between P (a new construct includes E1, E2, and E3) and C, and between P and E'. We found that the estimation between P and C is 0.512 (t = 8.320), between P and E' is 0.789 (t = 13.256), and between C and E' is 0.225 (t = 4.442). The fit indices AGFI = 0.82, RMSEA = 0.07, and Bentler comparative Fit = 0.97 show a good fit. This confirms the IT prototyping can enhance problem-solving skills.

The average scores of the items used to measure each construct are shown in Table 8. According to the students, the steps that improve communication skills are A1 (form an 8-10 person group) and A6 (in-class assignment). B3 (doing research for your project) is the most useful step for improving analytical skills, and C5 (group meeting) is the most helpful step for improving problem-solving skills. The model was

We note that prototyping improves communication skills (construct D), whereas system design (D3) is the most useful step for improving one's ability to propose strategies in a global environment, and lab tests (D6) are the least useful for developing this skill. Similarly, within the problem-solving skills (construct E), doing research for your project (E4) is the most helpful step for improving awareness of ethical issues in a business context and lab tests (E6) are the least useful. Finally, for advanced analytical skills (construct F), system analysis (F2) and doing research for your project (F4) improve learning in one or more functional areas of business management, whereas lab tests (F6) do not contribute to this skill.

Table 8 Average scores of items in constructs.

Item	A1	A2	A3	A4	A5	A6	A7	A8	A9	
Avg.	2.041	2.449	2.143	2.087	2.046	2.041	2.102	2.071	2.102	
Rank	1	9	8	5	3	2	6	4	6	
Item	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Avg.	2.13	2.15	2.02	2.45	2.20	2.25	2.17	2.19	2.29	2.21
Rank	2	3	1	10	6	8	4	5	9	7
Item	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Avg.	2.44	2.09	2.22	2.10	2.01	2.10	2.06	2.14	2.22	2.11
Rank	10	3	9	4	1	5	2	7	8	6
Item	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Avg.	2.21	2.16	2.03	2.16	2.25	2.42	2.35	2.30	2.18	2.32
Rank	5	3	1	2	6	10	9	7	4	8
Item	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Avg.	2.56	2.53	2.55	2.38	2.53	2.90	2.80	2.46	2.61	2.58
Rank	6	3	5	1	3	10	9	2	8	7
Item	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Avg.	2.04	1.93	2.04	1.96	2.21	2.43	2.30	2.21	2.19	2.27
Rank	3	1	4	2	6	10	9	6	5	8

Conclusions

This study analyzes the skill sets of 184 university business school students who took a required course in computer-based information system (CBIS). The data is from a questionnaire that asked students which of the course components best teaches communication, analytical, and problem-solving skills, which are considered critical skills for employability. The CBIS course not only covers essential IT knowledge and skills, it also encourages students to integrate the topics covered in class by developing a Web-based information system. Due to limitations in time and experience, the class only takes the system development process to the prototyping stage. This study explores whether the process of developing a prototype enhances the three essential skills all business students need. The results are as follows.

A CBIS course is more effective in teaching communication and problem-solving skills than in teaching analytical skills.

Building prototypes does not enhance analytical skills.

Building prototypes significantly enhances problem-solving skills and communication skills.

Of the 10 course stages (items), system design (D3) builds communication skills, research (E4) builds problem-solving skills, and both system analysis (F2) and research (F4) build analytical skills. The lab test (F6) contributes the least to skill development.

Discussion, Limitations, and Future Research

CBIS is not always a popular course among business students. However, a CBIS course that uses a system development life cycle model can help students develop communication, analytical, and problem-solving skills. Thus, a CBIS course that takes an IT project-centered approach can assist students to learn both essential computer system knowledge and the skills needed for graduation compatibility.

Due to resource limitations and time constraints, most CBIS courses stop at the prototyping stage of the product development life cycle. However, building a prototype is a systematic way to integrate advanced skills. Specifically, we expect students who complete our course to have effective business communication skills, effective analytical skills that support decision-making, the ability to integrate business knowledge and solve problems in a business environment, the ability to propose strategies in a global environment, awareness of ethical issues in a business context, and specific knowledge in one or more functional areas of business management. The first three goals of our course are to enhance communication skills, to improve analytical skills, and to develop problem-solving skills. Specifically, the course increases students' ability to propose strategies in a global environment, which is a communication skill; increases their awareness of ethical issues in a business context, which is a problem-solving skill; and teaches them specific knowledge in one or more functional areas of business management, which improves their analytical skills. We also argue that an awareness of ethical issues and the ability to position oneself with regards to this issues, demands advanced problem-solving skills.

Given the above argument, we assume that prototyping a Web-based information system can also help to achieve the three advanced goals. Our findings show that CBIS course has more effect on communication skills and problem-solving skills than on analytical skills. Also, the process of building a prototype can significantly enhance communication skills and problem-solving skills. The team-based IT prototyping enhances the communication skills that is in line with (Lin, et al., 2014) and (Wang, et al., 2014). However, the course does not significantly improve the analytical skills contradicting the findings in (Aesaert & Braak, 2014) that used pupils as the research subjects.

Building a prototype is a systematic way to integrate the various topics taught in a CBIS course. The process is most effective at enhancing problem-solving skills and communication skills, and only has a small effect on analytical skills, probably because business clients normally have lower expectations of student projects. The prototype process ends with the demonstration of the concept in a prototype. If the prototype were developed into a full-scale system, students might encounter more problems than they anticipated in the prototyping stage, including financial and human resources issues. Solving such problems would require good problem-solving skills and analytical skills. However, due to limited time, resources, and skills, the projects are not extended beyond the prototyping stage, and these issues are therefore not addressed in the class. The same issues and opportunities would occur in the technical support stage of a real-world system development life cycle.

This study has several limitations. CBIS courses focus on the prototyping phase of product development, so the skills learned in later stages are not covered in the course. Furthermore, we ask students to design real-world projects, and as a result the difficulty of the projects varies, and this increases the variance in this study. Also, the mix of students varies between groups, introducing another variable into the study. Furthermore, as CBIS is a required course, many topics need to be covered in the 14-week class and students with a wide range to abilities take the class together.

This study examines whether a class centered on building a prototype helps business students achieve their learning goals. The results show that building a prototype can significantly enhance communication or problem-solving skills, but not analytical skills. The results of the questionnaire suggest that students slightly agree that the course effectively teaches these skills. Future studies should consider how to improve the teaching of communication, problem-solving, and analytical skills, as well as other skills.

In this study, we define prototyping as a process that integrates problem definition, system investigation, system planning, and system design. Future studies should develop an instrument for measuring prototyping skills. Similarly, items could also be developed for measuring problem-solving, analytical, and communication skills. Better measurement tools would make it possible to use structural equation modeling to examine the relationships between skills. Moreover, we could also study the effect of prototyping on other learning factors.

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