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A Systematic Project-based Learning Model for Accounting Education in Engineering and its Application to Web-based Practice System

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Abstract. This study deals with how to apply PBL (Problem-based learning) model to interdisciplinary field such as engineering accounting. The PBL approach can provide a solution on the educational issues for engineering accounting and is an appropriate method for engineering perspective with a systematic view. An SPBL (Systematic project-based learning) model, a revised PBL and an application model to develop a web-based practice system, is proposed considering the academic features of engineering accounting, engineering students' learning characteristics as well as a systematic view of engineering discipline.

Keywords: Problem-based learning, Systematic project-based learning, web-based practice system, engineering accounting, Industrial & Management Engineering

1. Introduction

Engineers have been struggling to read even basic accounting documents such as the balance sheet or the income statement. It has been a big obstacle for their promotion to a manager. These experiences have made engineers in practice recognize needs of accounting education. Not surprisingly, senior engineers argue that the accounting courses customized to engineers should be developed and put in the curriculum urgently (Park, 2007). Especially in large companies, accounting information becomes more and more important because it enables employees not only to understand the overall financial status of any company, but to analyze the causal relationship between business activity and performance. Further, if engineers can monitor and analyze changing accounting information, they can identify promising business opportunities to increase productivity in either production or service system. Nowadays, any managers are required to analyze accounting documents, understand external changes and make strategic decisions by themselves.

Engineers have usually been put in R&D practice. However, they cannot concentrate on R&D as they were. Under severe R&D budget constraints, they are forced to manage the budget efficiently without any support of managerial staffs, and thus do accounting by themselves. It should be noted that any R&D process is hard to be standardized because it is full of unexpected events and intangible elements. It is no wonder that traditional accounting practices and measures are of little use (Cho, 2009). For instance, cost is easily defined in any production process, but is too complex to be defined even in the simplest R&D processes. Typical accounting education is not so much useful for engineers in practice. They are required to modify an old way of accounting, and further develop a new standard for today's R&D accounting. Considering these, we cannot help developing new engineering accounting education models and courses. Those are likely to be of great use for engineering students.

Driven by these needs, many new learning/teaching models have been developed, but are lopsided to contents. Practical education depends more on the interactions than on the contents because the learning-by-doing is far more effective that the lecture. In that regard, we suggest a new learning model based on PBL (problem or project-based learning), emphasizing the importance of knowledge creation and sharing. Barrows (1994) defines PBL as the learning that results from the process of working towards the understanding of a resolution of a problem, implying that it is a part of the shift from the teaching paradigm to the learning paradigm. The focus is what students are learning rather than what the teacher is teaching.

Operationally, given carefully designed problems and cases, a small group of students collaborates to solve the problem by using discussion and independent research. Teachers encourage students to engage actively in the collaboration by guiding the way of collaboration, providing information and stimulating discussion. Through the intensive problem-solving process, students become equipped with various capabilities including inter-disciplinary learning, peer reasoning, creativity and teamwork (Kang et al., 2005). A number of previous studies have reported that PBL should be of great help to students. The small group exercise stimulates communication between participants, and thus increases students' satisfaction (Kim, 2003). Focusing narrowly on engineering students, Kang et al. (2005) find that PBL should contribute a lot to developing both communication and presentation skills, and thus make students excited more than they were. Another study (Suh, 2007) examines PBL's effects on creativity and gets positive results.

From the previous studies, it is appropriate to use PBL for engineering accounting education characterized both by inter-disciplinary learning and exercise. Also from the viewpoint of pedagogy, PBL is a good way of bringing corporate accounting problems and practices under dynamic economic environment into a class. The only concern is that it is not much systematic. For application in engineering education, PBL has to become more systematic. Considering these, we modify the classic PBL, and suggest a new SPBL (systematic project-based learning) model and discuss an application method of SPBL to engineering education.

2. Needs of PBL for accounting education of engineering field

2.1. Industry needs

In Korean universities, Industrial Engineering Departments have offered accounting courses to students because they have entered a variety of industries including the traditional manufacturing (44%), the information and communication industry (24.3%), the service industry such as finance, logistics, retail, etc. (12.5%). Moreover, they have worked in various departments over R&D (20.0%), production (11.4%), consulting (11.3%), strategy (10.4%), sales/marketing (7.9%), finance/accounting (2.5%), etc. The job distribution has become more and more similar with that of business schools (Korea Research Foundation, 2006).

There is a perception that the accounting education will become more important, and be of great use in practice over various industries. Graduates from Industrial Engineering department agree with this statement, implying that the needs should be common over a number of industries. As shown in Fig. 1, industrial engineering students feel keenly the gap between accounting knowledge required in practice and that learned in the university. That is why they argue that advanced engineering courses should be developed and offered.

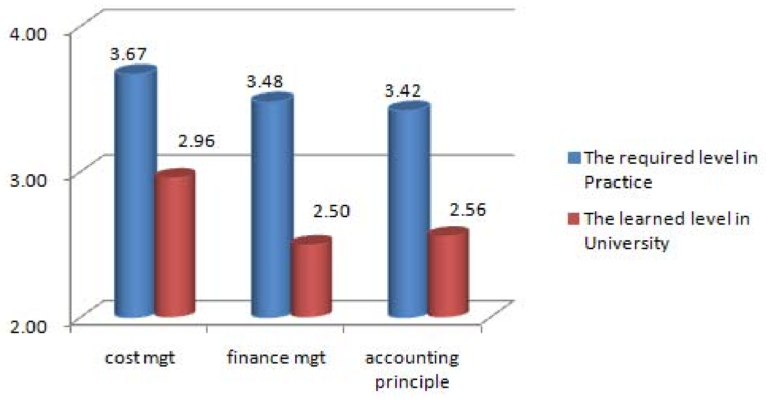

Fig.1: Evaluation on the usefulness of accounting courses in practice (Korea Research Foundation, 2006).

2.2. Engineering students' needs

A survey on the needs of accounting knowledge for engineering students has been made annually over last three years. Undergraduates have taking the engineering accounting course at Department of Industrial Engineering in Hankuk University of Foreign Studies in Korea are chosen. Annual average number of enrolled students at this class is 45 that are sufficient to identify their needs. To a question such as 'Will the knowledge acquired from the engineering accounting course be useful in the future', a survey result in 2009 shows that students answered 'useful'(17%), 'very useful(48%)' and 'will be a source of individual competitive advantage(30%)', meaning that there is a consensus on the future value of accounting knowledge. This is also supported by a survey in 2007 and 2008.

Put simply, there is a perception that accounting knowledge should be useful for engineering students. However, the class performance is somewhat below expectation. Although more than 80% of students answers that they can understand and analyze financial statements and are also good enough at cost accounting, the number of students beyond 'very good' level is below 27%. In other words, the proportion of students with mediocre accounting ability reaches up to 58%. They understand basic principles of accounting, but cannot have advanced accounting knowledge such as ABC (activity-based costing). Such a lack of practical abilities becomes apparent when we look into the self-evaluation score on the future value of accounting knowledge learned. Students more than 35% expect that basic terminology and accounting method will be used in practice, but they think that corporate financial analysis and cost planning will be of little use. The proportion of students who answer 'I will use cost accounting in practice' is 3%. Put simply, most of students (97%) perceives both necessity and usefulness of accounting in any corporate practice, and thus is engaged in acquiring basic knowledge. However, they are not prepared to do practical accounting.

To improve the current accounting courses in engineering schools, students hold a common view that practical exercises with real corporate cases should be put in the course. They expect that experience-oriented learning should be effective more than other approaches. Other complaints and needs are listed in following <Table 1>. Those are results of surveys over last three years, and arranged after eliminating answers either redundant or impossible. Key finding is that almost all of students are interested in engineering accounting and are eager to utilize knowledge for their future work and social life. Principal needs including 'Analytic exercise with balance sheets used in real companies', 'Virtual corporate management and accounting practice', 'Fundamental financial analysis for real equity investment', 'Practical accounting exercise' converge to maximize the future value of accounting knowledge in their future works, implying that accounting skills are expected to increase individual competitive advantages to great extent. Considering these, we argue that PBL should be one of the most appropriate methods for engineering accounting education. It is expected that PBL can meet almost all of students' needs previously mentioned, and thus bring up solid accounting abilities.

Table 1: Key needs and complaints for engineering accounting courses

Year	Needs and complaints
2007	- Practical exercise - Analytic exercise with balance sheets used in a real company - Virtual corporate management and accounting practice - Fundamental financial analysis for real equity investment - Budget and cost planning - Investment for young people - Time consideration for advanced contents - Advanced lecture on stock market, analysis and real investment - Lecture on up-to-date issues such as financial engineering, derivatives, etc.
2008	- Learning fatigue due to the fast pace - More case studies - Practical accounting exercise - Language problem - Lecture on the value and utilization of accounting knowledge both in work and life
2009	- Various problem solving - Practical exercise - Team analysis exercise with balance sheets used in a real company - Emphasis on exercises - Development of another way of learning

3. SPBL Model and Course Design for Engineering Accounting

Today's industrial problems have become more and more complex, involving a wide array of stakeholders. Those are usually composed of heterogeneous sub-problems from various domains. Collaborative problem-solving has been regarded as the best solution, and thus applied to so many projects in any organization. TF (task force) is a well-known organizational form to stimulate this process. Industrial Engineering, characterized by a systematic problem-solving process under continuously changing environment, has been at the forefront of this trend. Thus, accounting education in Industrial Engineering should build on a collaborative and systematic problem-solving process. In that regard, we suggest SPBL embodying both core concepts of PBL and systematic characteristics of Industrial Engineering. SPBL is also a basis to develop a web-based project system.

Looking into our SPBL more in details, we can visualize the concept structure as shown in Fig. 2. It is composed of the teacher, the learner and the web-based project system. Under the objective to equip students with practical accounting knowledge and skill, SPBL is designed to maximize interactions between three components both in efficient and effective manners. In a typical PBL, given the problem, learners usually find solutions with a teacher through direct interactions. However, in our SBPL system, the web-based project system plays an intermediate role between teacher and learner, and makes the interactions more systematic and convenient. Needs and feedbacks of learners are automatically collected, filtered and transferred to teachers. Reviewing these carefully, teachers improve the project system, and provide students with useful information. Students also can make interactions with teachers directly or using project system indirectly. Mediated by the project system, both teachers and learners make more efficient in-depth communications than PBL model.

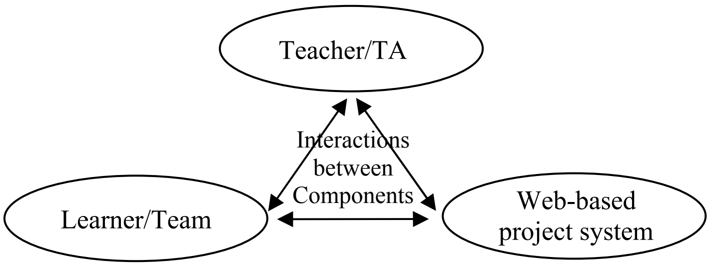

Fig. 2: SPBL concept structure

The first stakeholder, a teacher includes not only a lecturer but a T.A. (teaching assistant), a guest speaker, an external expert, etc. They provide learners with information, discuss the solution together, and guide them into a creative solution, and at the same time make efforts to improve the project system based on experiences through interactions. More in details, the teacher should make learners bear key class objectives in mind in the opening lecture, and introduce the way how SPBL works to learners. Once learners understand their roles and works, they are guided into SPBL's problem-solving process with pseudo-practical accounting problems. Teachers encourage them to do their best while making various interactions such as advices, discussion, etc. They are actually collaborative learners, and are different from traditional teachers. Suffice it to say that both effectiveness and efficiency of the course should depend heavily on teachers. Also, it should be noted that T.A. should play an important role, and contributes a lot to the success of the course. T.A. monitors the overall progress of all project teams, identifies key problems, checks the output, reports those to a lecturer, find the solutions together and make efforts to improve SPBL. Put simply, both lecturer and T.A. make interactions with students, and collaborate each other at the same time, implying that both interactions should increase the performance of students while improving SPBL system continuously.

Another important component is the learner. Several learners make a team to conduct a project. At first, they solve simple close-ended problems together, and are familiar with one another. Then, given an open-ended problem, works are allocated to team members by considering knowledge and skill identified through previous simple exercises. Each individual do an independent study and share acquired information with team members. If necessary, several teams can collaborate, and get some help from teachers. When a team completes the project, the results are organized logically, and then presented to other teams and teachers. Through the presentation, team members receive questions and comments on every sub-process of their problem solving including data collection, information filtering, logical thinking, methodology selection, etc. They are also required to self-rate their performances. Every team is equally important, and should make continuous interactions both with the web-based project system and the teacher. The former works both as a learning tool and a knowledge provider, and the latter plays roles of both guide and stimulator.

The final component is the web-based project system. Teachers and learners go to the homepage, sign up and login to it. Learners acquire and share information, knowledge, ideas and analytic results, make discussion and get helps both from teachers and other learners. Using the system, teachers can announce exercise problems, monitor the progresses of all teams, and make a variety of surveys on topics such as the team performance, user-friendliness of the system, etc. Two types of problems are provided. The first type is the simple close-ended problem including simple calculation of financial indicators, reading accounting documents, etc. on the assumption that a virtual corporate transaction is made. The second type, the open-ended problem, is close to a real accounting problem, and thus is more complex. On the assumption of a virtual market, market demands are randomly determined in a fiscal year. To meet demands, several companies from manufacturing and service sectors borrow money, invest, produce and supply goods and service. A team runs a company to maximize the profit, and make transactions with other companies. Through accounting practices, figures in transactions are arranged in financial statements which are used to analyze the corporate status and the performance from the financial perspective. Although this is a virtual simulation, the accounting problems are almost real, and thus help students develop practical accounting ability.

The SPBL model aims at maximizing positive interactions among three components (teacher, learner and web-based project system) in a systematic way. Brief description on SPBL's key components, interactions and functions is given in Table 2.

Table 2: Description of SPBL

Component	Description	Interaction type	Function
Teacher	Lecturer, T.A. guest speaker, external expert	Teacher-learner	Introduction, stimulation, monitoring, providing advices and information, guidance, evaluation
		Teacher-system	Project design, system update and maintenance
Learner	Students registered in the class forming a project team)	Learner-teacher	Team organization, work allocation, recitation for class improvement
		Learner-system	Problem solving, information collection, knowledge sharing, discussion, team-based learning, teamwork exercise
Web-based project system	Web-based system for practical team projects and exercises	System-teacher	Project performance evaluation, performance management
		System-learner	Presentation, self-evaluation, survey

4. Further study for a web-based practice system

This study's main objective is to suggest a new learning/teaching model named SPBL (systematic project-based learning). Although SPBL builds basically on the PBL, it incorporates characteristics of the engineering accounting course and needs of engineering students, especially including self-generating open-ended problem. By this way, SPBL becomes more systematic than PBL, and thus is appropriate for practical engineering accounting education. Taking a step further, we may customize SPBL to the engineering accounting course, and develop the web-based project system for implementation. In SPBL model, the web-based project system has a core role to help understand the management discipline in accounting education for engineers. The web-based project system must include the tutorial, the main and the monitoring programs. In the tutorial program, learners solve basic accounting problems, and are accustomed to the system. The main program is at the heart of the system where learners run companies, make pseudo-real transactions, do accounting and solve open-ended accounting problems. Teachers can monitor the learning progress of each team, and further manage both learning itself and the system through the monitoring program. The system is designed to maximize interactions between learner and teacher in a systematic and convenient manner. That is why it is developed under the web environment. This is also in line with the core concepts of SPBL. SPBL with the web-based project system is likely to encourage students to be involved actively in learning, and also make both teaching and learning more effective and efficient. Knowledge will be transferred to students more. It will lead to the better average performance of students. So, development of web-based project system and its application to college class as well as the effects of SPBL need to be examined in further studies.

5. References

[1] H. Barrow. *Practice-based learning: Problem-based learning applied to medical education*, Springfield, IL: Southern Illinois Univ. School of Medicine, 1994.

[2] E. Brideges, P. Hallinger. *Implementing problem-based learning in leadership development*, Eugene, OR: ERIC, 1995.

[3] S.P. Cho. Budget Management of Research and Development, in *Management of Technology*, Korea Industrial Technology Association (eds.), 2009, pp.67-71.

[4] T. Duffy, D. Jonassen. *Constructivism and the technology of instruction: A conversion*. New Jersey: Lawrence Erlbaum Association, 1992.

[5] I. A. Kang, S. J. Kim. Class design and application based on PBL: a case of elementary society class, *Journal of The Korean Society for Educational Technology*, 1998, 14(3): 1-31.

[6] S-Y. Kang, H-H. Cho, J-I. Hong, E-J. Kim, S-E. Park. The effect of problem based learning in engineering education, *Engineering Education Research*, 2005, 8(2): 24-34.

[7] Kim, E-J. (2003). The effects of cooperative learning on communication apprehension, academic achievement and students` satisfaction, The Korean Journal of Educational Psychology, 17(2): 215-232.

[8] Korea Research Foundation. *Creative Engineering Education System and Curriculum Development by Task Analysis and Case Analysis: Focused on Industrial Engineering*, 2006.

[9] G.H. Park. Suggestions for solving problems of the engineering education, *Engineering Education*, 2004, 11(1): 10-14.

[10] Y. Park. *Engineer and Management Mind*, Life & Power Press, 2007.

[11] R. Polanco et al. Effects of a problem-based learning program on engineering students' academic achievements in a Mexican university, *Innovations in Education and Teaching International*, 2004, 41(2): 145-155.

[12] H-E. Suh. The effects of improving creativity with a PBL-based robot education program - case of a Science High School, *Journal of The Korean Society for Engineering Education*, 2007, 10(4): 93-121.

[13] L. Wikerson, W. Gijelaers. *Bringing problem-based learning to higher education: Theory and practice*. San Francisco, CA: Jossey-Bass Publishers, 1996.