Exploring the Effects of Web-Enabled Problem-Based Learning and Self-Regulated Learning on Vocational Students' Involvement in Learning

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Abstract

Vocational degree earners represent a major portion of the work force in Taiwan. In courses of computer application software, however, most teaching and learning efforts have been devoted to helping students pass written tests, and thus, receiving official certificates. Under such constraints but moving toward more practical orientation, the authors first re-designed a course and then conducted a series of quasi-experiments to examine the effects of web-enabled problem-based learning (PBL), self-regulated learning (SRL), and their combinations on vocational students' involvement in learning. Two classes of 102 freshmen in a one-semester course were chosen for the empirical study. The results are mostly supportive. The authors further discuss the implications for schools, particularly vocational schools, and for scholars and teachers engaged in e-learning.

Keywords

Web-Based PBL, Web-Based SRL, e-learning, Involvement, Vocational Students, Application Software Education

Introduction

The networked technology applied in education holds significant potential for advancing the interactivity between learners and tutors, in offering flexibility regarding the means of learning, and in providing easy, one-stop maintenance and reusability of resources (Psaromiligkos, 2003). A course website contributes to students' learning process, e.g. it contributes to the clarification of the course material, it enables getting help from the course staff, and it facilitates getting fast response to questions (Benaya & Zur, 2007). However, success in online courses often depends on students' abilities to successfully direct their own learning efforts (Cennamo, Ross & Rogers, 2002).

In web-based learning environments, the physical absence of the instructor and the increased responsibility demanded of learners to effectively engage in learning tasks may present difficulties for learners, particularly those with low self-regulatory skills (Dabbagh & Kitsantas, 2005). Students in an online environment equipped with self-regulated learning competence become more responsible for their learning and more intrinsically orientated (Chang, 2005). Moreover, it is believed that self-regulation is particularly important when learning in WWW-supported environments (Winnips, 2000; Azevedo, Cromley, Winters & Moos, 2004). It is very critical to develop students' skills of self-regulated learning (SRL) and help them acquire SRL strategies before providing online courses to them.

Professionals with a vocational degree represent a major portion of the work force in Taiwan. Vocational education is highly competitive in that it must attract high enough student enrolments to achieve economy of scale in the face of a continually decreasing birth rate and the rapidly increasing number of schools. Students in these schools tend to have lower levels of academic achievement, and spend more time on part-time jobs, do not appropriately get involved in their schoolwork, and care less about their grades. Teaching in such contexts, particularly teaching the curriculum of application software, is a great challenge to most educators.

No one doubts the guiding principles of practical applications in the vocational education in

Taiwan (Tai, Chen & Lai, 2003). However, vocational schools, feeling the high pressure of market competition, often emphasize the proportion of students awarded related certificates before they graduate instead of quality learning. This materialist aim puts students' attention less on mastering application software and more on preparing for exams through memorization. Consequently, a student who has passed a certifying exam may still be unable to apply what was learned in school, and worse, lacks motivation to learn more in the future.

Courses in application software traditionally emphasize memorization by applying short, disjointed, lack-of-context examples. Even the professors in National Open University in Taiwan who teach on-the-job students Microsoft Office through television also tend to use short, inappropriate examples in their curricula. The lack-of-context examples in textbooks and used by lecturers may result in uncompetitive employees. There is a gap between what is learned in school and what is required in the workplace (Wu, 2000). In this regard, the computing education in vocational schools in Taiwan can hardly be deemed as effective.

In order to increase students' involvement and develop practical skills, problem-based learning (PBL) is considered to be most appropriate pedagogical choice. PBL uses real-world, simulated, contextualized problems of practice to motivate, focus and initiate content learning and skill development (Dunlap, 2005). Therefore, we believe that PBL would help vocational students to develop practical computing skills and learning motivation through online courses.

The strength of the Internet is to deliver information directly to individuals; however, that may also be one of its greatest dangers. Students retreating to the isolation of their computers may avoid school activities and course involvement, and instead be content with self-gratifying Internet entertainment (Treuer & Belote, 1997). Many vocational students are addicted to shopping websites, online games, and online messengers, and prefer this rather than getting involved in courses, particularly in online courses. To respond to this challenge, we turn to some approaches that can help students better regulate and become involved in their learning.

Researchers have consistently shown that, while self-regulation helps high achievers reach their potential (Risemberg & Zimmerman, 1992), it also makes a difference between failure and success for low achievers (Borkowski & Thorpe, 1994). However, there has been relatively little empirical research on students' SRL with such complex technology-based learning environments (Azevedo & Cromley, 2004). Therefore, we apply SRL in this study to help vocational school students concentrate on and be involved in their learning, make time for learning after their part-time jobs, and furthermore, take responsibility for their learning.

Few studies have discussed effective online teaching methods for vocational students. In this area, the restructuring and translation of traditional computer software courses into teaching websites has seldom been documented. Thus, we have redesigned a course in application software to integrate innovative teaching methods and learning technologies to help students learn and apply what they have learned. Further, we also expect that innovative teaching methods will increase students' involvement in online courses. The understanding of factors that predict involvement in learning and development activities is very important. This can increase theoretical understanding, not only of the types of people that get involved in learning, but also the types of contexts or situations that may facilitate involvement (Maurer, Weiss & Barbeite, 2003). Specifically, this study explores the potential effects of web-based PBL and SRL on the development of vocational students' involvement in an online course. Based on suggestions from earlier research, we have re-designed a course and conducted a series of quasi-experiments to examine the effects of web-enabled PBL, SRL, and their combinations on vocational students' involvement in learning.

Literature Review

Involvement

Involvement is defined by Zaichkowsky (1985) as a person's perceived relevance of the object based on inherent needs, values, and interests. Many scholars accept the involvement concept as a key determinant of learning outcomes. Tinto (1993) illustrated that the more students are involved academically and socially, the more likely they are to become involved in their own learning and to invest time and energy in the learning process. Involvement, especially academic involvement, seems to generate strengthened student effort, then leads to enhanced learning (Tinto, 1993).

Schmidt and Frieze (1997) indicate that many researchers' definition of involvement seems to closely resemble that of motivation as described by McClelland (1987). In Astin's (1999) research, his results strongly support the importance of involvement as a powerful means of improving almost all aspects of the undergraduate student's cognitive and affective development. However, teachers face challenges to help students be involved in an online course in an environment that is full of Internet addiction. It is necessary to investigate the potential effects of web-based PBL and SRL on the development of vocational students'

involvement in learning in an online course.

Problem-Based Learning

Problem-based learning (PBL) is a teaching method that may engage students in authentic learning activities that use professional problems of practice as the starting point, stimulus, and focus for learning (Barrows, 1985, 1986). PBL promotes student learning based on the need to solve problems. It not only emphasizes the learning of the subject area, but also provides opportunities for students to practice and apply many skills and knowledge.

In constructivist pedagogies, the teacher plays the role as a creative mediator of the process. Class time might become a project-oriented session where the instructor provides tools to help learners to construct their own views of reality (Leidner & Jarvenpaa, 1995). PBL, which evolved from the Constructivist Learning Theory, helps students to acquire knowledge and improve understanding from the processes of solving problems. It is reported that students' experience of being involved occurred when they were able to concentrate deeply and to understand both the task and its content (Reed & Schallert, 1993). Learning in a meaningful context will be more easily retrieved than that which is acquired in isolation. The resemblance between the context for learning and the context of future application facilitates the transfer of knowledge (Charlin, Mann & Hansen, 1998).

Web-based instruction seems to be an ideal learning environment because students can access an almost unlimited amount of information and apply it in multiple ways (Kauffman, 2004). However, Robey, Khoo & Powers (2000) indicate that a virtual learning community could not really solve the problems encountered in online learning if learners do not learn through problem-based learning or in project-based learning situations. Good learning can be characterized as collaborative and social. Sharing one's ideas and responding to others improves thinking and deepens understanding (Chickering & Gamson, 1997; Power & Guan, 2000). In Chanlin and Chan's (2004) study that uses PBL in web-based instruction, it was revealed that students in the PBL treatment reflected more variation in peer assessment. More commendations and criticisms in reference to peers' effort and involvement were obtained from PBL group members. That is, students who learn in a realistic situation set by the web-enabled constructivist pedagogies may also experience increased involvement. Therefore, it can be summarized: *In the web-enabled learning environment deploying a PBL instructional method, students' involvement in learning is positive, and higher than those taught without a PBL instructional method*.

Self-Regulated Learning

Zimmerman and Schunk (1989) define self-regulated learning (SRL) in terms of self-generated thoughts, feelings, and actions, which are systematically oriented toward attainment of students' own goals. SRL is also defined as a learner's intentional efforts to manage and direct complex learning activities and is composed of three primary components including cognitive strategy use, meta-cognitive processing, and motivational beliefs (Kauffman, 2004).

Lindner and Harris (1993) indicate that SRL creates a more active involvement on the part of the learners as they have to assess the situation based on their own abilities and use the learning skills that they see as appropriate or successful. In Pearson and Chatterjee's (2001) study, they transform the pedagogy from teacher-directed to student-centered. The program provided educational and experiential learning for students to facilitate meta-cognitive and self-regulated learning development. Noticeable outcomes were greater involvement of all students in the tutorials (Pearson & Chatterjee, 2001; Beasley & Pearson, 1999).

Some investigations have pointed to how self-regulation may be tied to involvement as an antecedent to the process, a stimulus that uses volitional strategies to move a learner from a self-focused state into immersion in a task (Reed, Hagen, Wicker & Schallert, 1996; Reed & Schallert, 1993; Schallert & Reed, 1997). It is found that self-regulatory volitional strategies play a major role in helping students become involved in their quantitative studies (Reed, Schallert & Deithloff, 2002). Montalvo and Torres (2004) also indicate that SRL learners show greater efforts to participate in the control and regulation of academic tasks, classroom climate and structure to the extent that the context allows it.

It is concluded that students in SRL environments are more motivated to learn, report more enjoyment of the material and are more actively involved in their learning than those who study in more restrictive environments (van Grinsven, 2003; van Grinsven & Tillema, 2006). Therefore, based upon the literature we reviewed in this section, it is hypothesized that: *In the web-enabled learning environment deploying an SRL instructional method, students' involvement in learning is positive, and higher than those taught without an SRL instructional method.*

Problem-Based Learning and Self-Regulated Learning

In PBL, students work in collaborative groups to identify what they need to learn in order to solve problems. They engage in self-directed learning (SDL) and then apply their new knowledge to the problems and reflect on what they have learned and the effectiveness of the strategies they have employed. That is, PBL is well suited to helping students to become active learners because it situates learning in real-world problems and makes students responsible for their learning (Hmelo-Silver, 2004). PBL is a specific task-based approach that teachers can apply to support the development of SRL. If PBL activities are designed carefully with teachers who provide appropriate modelling and scaffolding, they facilitate and necessitate SRL. PBL facilitates SRL because it places the responsibility on the students to discover information, to coordinate actions and people, to monitor understanding, and to reach goals (Paris & Paris, 2001).

Combined training in self-regulatory and problem-solving strategies is effective for enhancing self-regulatory competencies in solving mathematical problems (Perels, Gürtler & Schmitz, 2005). Kramarski and Gutman (2006) compared the treatments of e-learning with SRL and without SRL in solving mathematical problems. Their results showed that SRL students significantly outperformed the non-SRL students in problem-solving procedural and transfer tasks regarding mathematical explanations in a web-based learning environment. However, there are very few studies that discuss the effects of PBL and SRL simultaneously, particularly through teaching websites. According to the literature reviewed in this study, it is believed that students' involvement in learning will be even stronger when teachers arouse students' interest, then lead them to apply their skills and knowledge to solve problems with PBL and SRL intervention.

In this research, we hypothesize that students working with the study task variant with SRL focusing on the aspects of PBL would gain more from involvement in this online course than students studying the task without these co-existing treatments. Also, we hypothesize that the involvement of PBL and non-SRL group or non-PBL and SRL group is higher than that of the non-PBL and non-SRL group. That is, the highest increase of involvement in learning packaged software is expected in conditions wherein students are confronted with the situation of simulated problems, engaging in SRL without teachers' pressure. Therefore, this paper proposes: *In the web-enabled learning environment deploying a PBL AND SRL intervention, students' involvement in learning is positive, and higher than those without PBL and SRL intervention*.

Methods

Participants

The participants in this study are 102 freshmen students taking a compulsory course titled 'Packaged Software and Application' in a university of science and technology in Taiwan. None of them major in information or computer technology. However, in such an institution for technological/vocational education, practical applications of technology are considered as core skills (Tai, Chen & Lai, 2003). Students at this university are expected to spend much more time and efforts in mastering a variety of technological skills as compared to those in comprehensive universities in Taiwan.

Course Setting

Under study is a semester-long, 2 credit-hour course targeting first-year college students in different majors. Students solve a series of simulated tasks by applying Microsoft Office (including Word, Excel, and PowerPoint).

Of the sixteen weeks in this semester, nine of the two-hour class periods are conducted in a traditional classroom, while seven of them are provided via course website. In the first three weeks, the course is conducted in a traditional classroom. Students are encouraged to adapt to learning in a course website. After three weeks, most of the coursework is moved onto the website.

The teacher makes audio recordings of every session of his lecture and later on transforms lectures into HTML files with flash, visuals, and voice. These HTML files are then loaded into the course website. Students can preview and review the course sessions on this course website.

The course design in this study consists of three subsequent modules: the Word module, the Excel module, and the PowerPoint module. A skill test is held after the completion of each module. Students are required to come back to the classroom for the three tests. In the weeks before the tests, students also have to attend classes in the classroom for asking questions and hearing explanations. The schedule of module teaching and skill tests is depicted in Figure. 1.

T	T	T	O	O	O	T	T	O	O	O	T	T	O	T	T

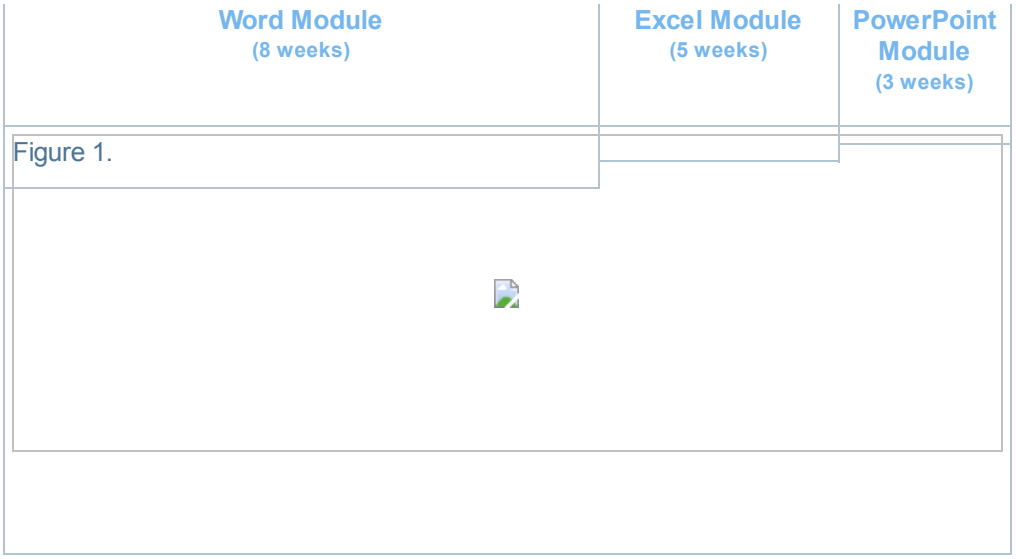

Figure 1. The schedules of the three modules and skill tests (T: traditional classroom classes; O: online classes)

Experimental Design and Procedure

The experimental design is a 2 (PBL vs. non-PBL) × 2 (SRL vs. non-SRL) factorial pre-test - post-test design (see Figure 2). Students in the four groups solve the same tasks but in different learning conditions. The participants are randomly assigned to one of the four experimental conditions in such a way that each condition contains 24 to 30 subjects. The PBL and SRL group (C1, n=28), PBL and non-SRL group (C2, n=25), non-PBL and SRL group (C3, n=24) are experimental groups, while non-PBL and non-SRL group (C4, n=25) is the control group.

	PBL	non-PBL
SRL	The most significant effect (C1 Group)	Medium effect (C3 Group)
non-SRL	Medium effect (C2 Group)	No difference (C4 Group)

Figure 2. The expected effects of variation in instructional methods

This experiment is conducted in two real classes, therefore, the sample size may be one of the limitations in this study. However, the sample size in this study is large enough to be tested in both t-test and ANOVA. For example, there are enough samples to use the independent samples t-test to compare students' involvement between PBL (n=53) and non-PBL teaching methods (n=49).

All participants complete the questionnaire of Personal Involvement Inventory (PII) developed by Zaichkowsky (1985) three times. The first questionnaire is delivered in the beginning (2nd week) of each class just before the start of the experiment. The second questionnaire is administered during the midterm examination (8th week) and the final one directly after the experiment concludes.

PBL Treatment

Popular software is taught in the course. The teacher creates interesting, challenging, and simulated problem situations. In the PBL class, the teacher first illustrates the procedures and functions of Microsoft Office. Then, the simulated situations and problems to be solved are explained to the students. They have to consider and discuss with their team members how to solve the problems by applying the skills and knowledge they just learned. In the Word module, students are required to apply for a job as "marketing assistant" in an online game company. They are required to design and then build autobiographies and resumes by applying skills of application software that they have just learned. In the Excel module, students play roles as if they are employed by this same software company, and a marketing manager asks them to compare expenses resulting from different distribution channels. They have to survey for information, then complete a worksheet with some graphs to contrast differences between channels. Additionally, they must come up with a recommendation regarding the best combination of channels. In the last module, PowerPoint, they are promoted to the higher rank of Marketing Managers. They are asked to develop a business proposal for a new on-line game.

They have to present this proposal with visual aids to convince the managing director to enter the market. Therefore, a persuasive PowerPoint file is built into this phase.

Some of the tasks require teamwork. Students have to collaborate and contribute their ideas to complete the tasks. Students could discuss ideas with their team members in the traditional classroom, online forums, chat rooms, or via online messengers. However, some simple schoolwork can be completed by individuals. For example, the requirement to complete a resume in Word does not urgently require group cooperation. Therefore, the intervention of PBL in the course titled 'Packaged Software and Application' does not entirely meet all the conventional requirements for PBL.

The teacher first demonstrates how he could approach the situation and solve the problem through web-based multimedia. In addition to the teaching of skills of application software, similar situations and related applications are also discussed in the class. In the latter, the teacher guides students in constructing their own models of problem-solving.

SRL Treatment

There is an SRL group within each class. Students in SRL groups receive instruction in an after-school course teaching SRL strategies. The two SRL groups from the PBL class and non-PBL class are gathered in a classroom and a two-hour lecture is delivered discussing how to manage study time and regulate their learning. The content of this SRL course is composed of the four processes addressed by Zimmerman, Bonner and Kovach (1996), that is, self-evaluation and monitoring, goal-setting and strategy planning, strategy implementation and monitoring, and monitoring of the outcome of strategy. Students are taught how to implement these four processes to become more self-regulated learners. For example, students are firstly required to record their learning behaviour when learning new subjects with unfamiliar skills. They may find that they waste much time on unrelated matters. The learning journals could provide feedback and reflection for them to monitor their own learning. Then, students have to analyze the tasks, set their learning goals, and adopt appropriate strategies to achieve their goals. In the implementation of learning strategies, students have to record the adopted strategies and their performance. Finally, students monitor the different strategies and results to find their effects.

In addition to the two-hour lecture, students in the SRL groups are required to regularly prepare for lessons and read the textbook chosen for the course, 'Microsoft Office 2003 – The Learning Treasury' (ISBN: 9861292292), before classes, and to review or practice, after class, the skills of applying application software they have learned. They are also required to record their learning behaviour every week. The data is recorded on the course website instead of in their notebooks in order to prevent falsification of records. The teacher casually examines students' records. The treatments in the four groups are illustrated and compared in Table 1.

Table 1. Teaching and learning activities in different experimental groups

Group	Teaching Activities	Learning Activities
C1	The teacher… • demonstrates how to solve simulated problems and discusses its potential applications. • teaches SRL skills and urges students to study regularly.	The students… • take on simulated tasks and learn by problem solving. • practice SRL and record learning behaviours every week.
C2	The teaching activities are the same as C1 but without SRL lectures.	The students experience simulated situations and solve the problems without extra requirements of SRL.
C3	The teacher… • converts his traditional way of teaching without any modification into an online format. • teaches SRL skills and urges students to study regularly.	The students… • receive the traditional computer software course through Internet. • practice SRL and record learning behaviors every week.
C4	The teaching activities are the same as C3 but without SRL lectures.	The students experience the traditional style of teaching and do not deal with the extra requirements of SRL, although teaching is

		conducted via the Internet.

Measures

The instrument used in this study is that of Zaichkowsky (1985), which measures the psychological states regarding personal relevance or importance of an object. Zaichkowsky's Personal Involvement Inventory (PII) measures three constructs: interests, needs, and values. Twenty seven-point bi-polar semantic differential items were used. It has been operationalised many times to measure one or more domains (Aldlaigan & Buttle, 2001). Besides, the definition of involvement used in constructing the PII has much in common with motivational theory (Schmidt & Frieze, 1997). Because a web-enabled course demands lots of student attention to adaptation or changes in their learning related activities, it is believed that the involvement construct could be an important construct in an online course.

To examine levels of change manipulated by variations in experimental conditions, we first measure students' involvement in learning application software as a baseline before the start of the experiment. In the second week, students complete the first questionnaire as a pre-test. The difference among the four groups in students' involvement in learning application software at this beginning stage is not statistically significant (see Table 2). Therefore, we consider that the students have equal involvement when they take this course. In addition, none of them have any prior experience in taking a web-based course. We then evenly and randomly divide the students into the four experimental groups.

Table 2. One-way ANOVA: Pre-test of students' involvement in learning

Pre-test	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Scheffe						Lower Bound	Upper Bound
	C1	C2	-.36893	.17889	.242	-.8778	.1400
		C3	-.03634	.18085	.998	-.5508	.4781
		C4	-.01093	.17889	1.000	-.5198	.4980
	C2	C1	.36893	.17889	.242	-.1400	.8778
		C3	.33259	.18579	.366	-.1959	.8611
		C4	.35800	.18388	.291	-.1651	.8811
	C3	C1	.03634	.18085	.998	-.4781	.5508
		C2	-.33259	.18579	.366	-.8611	.1959
		C4	.02541	.18579	.999	-.5031	.5539
	C4	C1	.01093	.17889	1.000	-.4980	.5198
		C2	-.35800	.18388	.291	-.8811	.1651
		C3	-.02541	.18579	.999	-.5539	.5031

* The mean difference is significant at the .05 level.

Finally, the enhancement of involvement in learning is the score on one's third questionnaire minus his score on the first questionnaire. We test the differences in the enhancement of involvement in learning application software under different conditions.

Results

To examine levels of change manipulated by variants in experimental conditions, we first measure students' involvement in learning in the course of 'Packaged Software and Application' as a baseline before they begin the course. This pre-test confirms that the difference in students' involvement in learning among the four groups is not statistically significant at this beginning stage.

The independent samples t-test is used to compare the involvement in learning and its improvement between PBL and non-PBL teaching methods. In the final questionnaire delivered at the end of the semester, students' involvement in learning in the PBL class (5.3708) is on average higher than that in the non-PBL class (4.8745) (see Table 3). Moreover, the improvement in the students' involvement in learning in the PBL class (0.3057) is significantly higher than that in the non-PBL class (-0.0400) (see Table 4). Therefore, the effects of web-based PBL on students' involvement in learning application software are positive, and higher than for those who do not receive PBL.

Table 3. Independent samples t-test: Involvement in learning

		n	Mean	S. D.	F	t-value	df	*P*
Involvement	PBL	53	5.3708	.62699	.020	3.959	100	.000**
	non-PBL	49	4.8745	.63829				

** $P < 0.05$; * $P < 0.1$

Table 4. Independent samples t-test: The improvement of Involvement in learning

		n	Mean	S. D.	F	t-value	df	*P*
Involvement	PBL	53	.3057	.90025	2.389	2.164	100	.033**
	non-PBL	49	-.0400	.68924				

** $P < 0.05$; * $P < 0.1$

Results from Table 5 show that students' involvement in learning in the SRL group (5.1202) is not higher than that in the non-SRL group (5.1450). Neither is there significant difference in the improvement of involvement in learning between the SRL group (0.2123) and the non-SRL group (0.0640) (see Table 6). The effects of web-based SRL on students' involvement in learning application software are more highly non-significant than those without SRL intervention.

Table 5. Independent samples t-test: Involvement in learning

		n	Mean	S. D.	F	t-value	df	*P*
Involvement	SRL	52	5.1202	.65979	.240	-.184	100	.854
	non-SRL	50	5.1450	.70060				

** $P < 0.05$; * $P < 0.1$

Table 6. Independent samples t-test: The improvement of Involvement in learning

		n	Mean	S. D.	F	t-value	df	*P*
Involvement	SRL	52	.2123	.86099	.441	.912	100	.364
	non-SRL	50	.0640	.77749				

** $P < 0.05$; * $P < 0.1$

Finally, the data from Table 7 shows that the combination of PBL and SRL intervention in a group (C1) results in the highest improvement of involvement in learning among the four groups, the improvement of involvement in learning in the PBL and non-SRL group (C2) or non-PBL and SRL group (C3) are also better than that in the non-PBL and non-SRL group (C4). That is, C4 exhibits the poorest improvement of involvement in learning among the four groups. However, there is no significant difference of improvement of involvement in learning among the four groups.

Table 7. One-way ANOVA: The improvement of Involvement in learning

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
Average	Scheffe	C1	C2	.19243	.22304	.863
			C3	.39893	.22548	.377
			C4	.47243	.22304	.221
		C2	C1	-.19243	.22304	.863
			C3	.20650	.23164	.851
			C4	.28000	.22927	.685
		C3	C1	-.39893	.22548	.377
			C2	-.20650	.23164	.851
			C4	.07350	.23164	.992
		C4	C1	-.47243	.22304	.221
			C2	-.28000	.22927	.685
			C3	-.07350	.23164	.992

* The mean difference is significant at the .05 level.

Discussion and Implications

Teachers face tremendous challenges in implementing e-learning among relatively low academic achievers. For example, Internet addiction is common, and free online games are easy to download, so it is not immediately clear how to focus students' attention, improve their learning, and help them be more involved in a web-based course without the teacher's on-the-spot monitoring. In this regard, we believe that our research contributes to e-learning theory in three different ways. First, our research specifies how teachers can improve vocational students' involvement in learning under simulated conditions by applying PBL instructional methods in a web-based learning environment. Second, this study is one of the first attempts to explore the learning effects of the various combinations of PBL, SRL, and web-based learning. Finally, this empirical study provides evidence that low academic achievers' involvement in learning can be improved through e-learning without teacher's on-the-spot monitoring.

As to our first teaching method, PBL was found to play a positive role in enhancing students' involvement in learning in the online course (see Table 4). There are significant differences between the PBL and non-PBL groups, either in the case of students' involvement in learning (P = 0.000, see Table 3) or in the enhanced involvement in learning (P = 0.033, see Table 4). It is demonstrated that PBL can help relatively low-achieving vocational students involve themselves in learning an online course through conscientiously designed and simulated problems. Teachers can redesign their courses by simulating meaningful and interesting business situations, and thus engage students' imagination and interest to solve challenging problems.

With respect to the second research question about SRL, the data shown in Table 6 indicates that the difference of students' involvement in learning in the online course between SRL and non-SRL group is not statistically significant (P = 0.364). There are some reasons for the non-significant results. First, students' resistance to change and adaptation to new ways of learning are the major reason. According to our teaching experience, students in most vocational schools in Taiwan tend to have lower levels of academic achievement, and spend more time on part-time jobs, do not appropriately get involved in their schoolwork, and don't care so much about their grades. It is very difficult to change their learning behaviours and habits in a one-semester intervention because they have not taken the responsibility for their learning since childhood. Along the way, the lecturer almost gave up his SRL intervention because of students' resistance.

Second, the effects of SRL in a one-semester course may dissolve if other courses that students are taking still employ "spoon-feeding" teaching methods. Other teachers in the same

college should cooperate to immerse students in a SRL-like environment. As time goes by, they may have a better chance to become self-regulated learners.

The final reason for the low significance may come from the limitation in teacher monitoring and feedback to students. When initiating web-enabled SRL, a teacher should pay more attention to students' learning behaviours and performance so that all the students study or practice regularly and record their learning every week on the website to prevent falsifying. It is also very critical for the teacher to monitor students' learning via their learning records and to give timely feedback to increase students' awareness of their inappropriate learning behaviours. However, the teacher did not pay much attention to students' learning because of the complex design and his unfamiliarity with innovative teaching methods and technologies adopted in this study. Therefore, it is suggested that teachers should care more for students' online learning, particularly in the environment where Internet addiction and the lack of on-the-spot monitoring are influences.

With respect to the third research question about the combination of PBL and SRL, the results show that the effects of a combination of PBL and SRL intervention on students' involvement in learning are positive and higher than for those who do not receive PBL or/and SRL, though non-significantly (see Table 7). The reasons for the non-significant results may still be that the SRL intervention did not cause the anticipated effects for the PBL and SRL group (C1). That is, students' resistance to change and adaptation of new ways of learning leads to limited effects, and further results in non-significant outcomes for our third hypothesis.

Based on our findings, there is a warning signal for teachers who plan to implement e-learning, particularly in vocational schools. For those teachers who wish to stick to traditional methods of teaching, directly translating their teaching materials into electronic form may not be a fruitful approach. Students in the control group (C4) exhibited the poorest involvement in learning among the four groups (see Table 7). It is suggested that teachers should redesign their courses and then adopt new instructional methods and technologies to fully exploit the benefits of web-based learning environments.

In this attempt to apply some innovative teaching methodologies, students' involvement in learning is enhanced in the PBL condition. However, the implementation and various combinations of teaching methodologies should be elaborated, refined, and coordinated. In addition to the web-based PBL and SRL in this study, other innovative teaching methodologies may be incorporated to contribute to students' learning. Researchers may imitate or modify this design to fit their needs. This study may provide valuable insights and shed light on new and effective practices for schools (particularly vocational schools), scholars and teachers preparing for or presently engaged in implementing e-learning.

References

[1] Aldlaigan, A. H. & Buttle, F. A. (2001). Consumer involvement in financial services: an empirical test of two measures. *International Journal of Bank Marketing*, 19(6), 232-245.

[2] Astin, A. W. (1999). Involvement in learning revisited: lessons we have learned. *Journal of College Student Development*; 40(5), 587-598.

[3] Azevedo, R. & Cromley, J. G. (2004). Does training on self-regulated learning facilitate students' learning with hypermedia? *Journal of Educational Psychology*, 96(3, 523-535.

[4] Azevedo, R., Cromley, J. G., Winters, F. I., & Moos, D. C. (2004). Designing adaptive scaffolds in hypermedia to facilitate students' self-regulated learning, Paper to be presented at *the Annual Conference of the American Educational Research Association*, San Diego, CA.

[5] Barrows, H. (1985). *How To Design A Problem-Based Curriculum for the Preclinical Years*, New York: Springer.

[6] Barrows, H. (1986). A taxonomy of problem-based learning methods. *Medical Education*, 20(6), 481-486.

[7] Beasley, C. J. & Pearson, C. A. L. (1998). Strategies for student transformation: The story of an "upside-down" course. In First Year Higher Education: Strategies for Success in Transition Years. (Proceedings of the Third Rim Conference 5-8 July). Auckland Institute of Technology, New Zealand, 2, 1-14.

[8] Benaya, T. & Zur, E. (2007). Website usage in a computer science course given in a distance learning environment. *European Journal of Open, Distance and E-Learning*, 2007(1). Retrieved November 9, 2007 from http://www.eurodl.org/materials/briefs/2007/Benaya_Zur.htm

[9] Borkowski, J.G., & Thorpe, P.K. (1994). Self-regulation and motivation: a life-span perspective on underachievement. In D. H. Schunk & B. J. Zimmerman (Ed.), *Self-regulation of*

learning and performance (pp. 45-73). Hillsdale, NJ, Lawrence Erlbaum Associates.

[10] Cennamo, K. S., Ross, J. D. & Rogers, C. S. (2002). Evolution of a web-enhanced course: Incorporating strategies for self-regulation. *Educause Quarterly*, No 1, 28-33.

[11] Chang, M. M. (2005). Applying self-regulated learning strategies in a web-based instruction - an investigation of motivation perception. *Computer Assisted Language Learning*, 18(3), 217-230.

[12] Chanlin, L. J. & Chan, K. C. (2004). Assessment of PBL design approach in a dietetic web-based instruction. *Journal of Educational Computing Research*, 31(4), 437-452.

[13] Charlin, B., Mann, K., & Hansen, P. (1998). The many faces of problem-based learning: A framework for understanding and comparison. *Medical Teacher*, 20(4), 323-330.

[14] Chickering, A. & Gamson, Z. (1997). Seven principles for good practice in undergraduate education. *AAHE Bulletin*, 39(7), 3–7

[15] Dabbagh, N., & Kitsantas, K. (2005). Using web-based pedagogical tools as scaffolds for self-regulated learning. *Instructional Science*, 33(5–6), 513–540.

[16] Dunlap, J. C. (2005). Changes in students' use of lifelong learning skill during a problem-based learning project. *Performance Improvement Quarterly*, 18(1), 5-33.

[17] Hmelo-Silver, C. E. (2004). Problem-based learning: what and how do students learn? *Educational Psychology Review,* 16(3), 235-266.

[18] Kauffman, D. F. (2004). Self-regulated learning in web-based environments: instructional tools designed to facilitate cognitive strategy use, metacognitive processing, and motivational beliefs. *Journal of Educational Computing Research*, 30(1 & 2), 139-161.

[19] Kramarski, B., & Gutman, M. (2006). How can self-regulated learning be supported in mathematical E-learning environments? *Journal of Computer Assisted Learning*, 22(1), pp. 24–33.

[20] Leidner, D. E., & Jarvenpaa, S. L. (1995). The use of information technology to enhance management school education: a theoretical view. *MIS Quarterly*, 19(3), 265-291.

[21] Lindner, R.W. & Harris, B. (1993). Teaching self-regulated learning strategies. In, M. R. Simonson & K. Abu-Omar, (Ed.) *Proceedings of selected research and development presentations at the annual conference of the Association for Educational Communications and Technology*, (pp. 641–654). Ames, IA: Instructional Resources Center, Iowa State University.

[22] Maurer, T. J., Weiss, E. M., & Barbeite, F. G. (2003). A model of involvement in work-related learning and development activity: the effects of individual, situational, motivational, and age variables. *Journal of Applied Psychology*, 88(4), 707–724.

[23] McClelland, D.C. (1987). *Human motivation*, New York: Cambridge University Press.

[24] Montalvo, F. & Torres, R. (2004). Self-regulated learning: Current and future directions. *Electronic Journal of Research in Educational Psychology*, 2(1), 1-34.

[25] Paris, S. G. & Paris, A.H. (2001). Classroom applications of research in self-regulated learning. *Educational Psychologist*, 36(2), 89-101.

[26] Pearson, C. A. L. and Chatterjee, S. R. (2001). Developing teaching environments for self-regulated learners: A longitudinal assessment with international students. In L. Richardson and J. Lidstone (Ed.), *Flexible Learning for a Flexible Society*, 545-553. Proceedings of ASET-HERDSA 2000 Conference, Toowoomba, Qld, (pp. 2-5). July 2000. ASET and HERDSA. http://www.aset.org.au/confs/aset-herdsa2000/procs/pearson.html

[27] Perels, F., Gürtler, T. & Schmitz, B. (2005). Training of self-regulatory and problem-solving competence. *Learning and Instruction*, 15(2), 123-139.

[28] Power, M. S. & Guan, S. (2000). Examining the range of student need in the design and development of a web-based course. In Abbey, B. (Ed.) *Instructional and Cognitive Impacts of Web-Based Education*, (pp. 200–216). London: Idea Group Publishing

[29] Psaromiligkos, Y. (2003). Re-evaluating the effectiveness of a web-based learning system: A comparative case study. *Journal of Educational Multimedia and Hypermedia*, 12(1), 5-20.

[30] Reed, J. H., Hagen, A. S., Wicker, F. W., & Schallert, D. L. (1996). Involvement as a temporal dynamic: Affective factors in studying for exams. *Journal of Educational Psychology*,

88, 101–109.

[31] Reed, J. H., & Schallert, D. L. (1993). Discourse involvement: An exploration of a cognitive/motivational construct in academic discourse tasks. *Journal of Educational Psychology*, 85, 253–266.

[32] Reed, J. H., Schallert, D. L., & Deithloff, L. F. (2002). Investigating the interface between self-regulation and involvement processes. *Educational Psychologist*, 37(1), 53–57.

[33] Risemberg, R., & Zimmerman B.J. (1992). Self-regulated learning in gifted students. *Roeper Review*, 15(2), 98-101.

[34] Robey, D., Khoo, H. & Powers, C. (2000). Situated learning in cross-functional virtual teams. *Technical Communication*, 47(1), 51-66

[35] Schallert, D. L., & Reed, J. H. (1997). The pull of the text and the process of involvement in one's reading. In J. Guthrie & A. Wigfield (Ed.), *Promoting Literacy through Integrated Teaching*, (pp. 68–85). Chicago: International Reading Association.

[36] Schmidt, L. C. & Frieze, I. H. (1997). A mediational model of power, affiliation and achievement motives and product involvement. *Journal of Business and Psychology*, 11(4), 425-466.

[37] Tai, C. F., Chen, R. J. & Lai, J. L. (2003). How Technological and Vocational Education Can Prosper in the 21st Century? *IEEE Circuits & Devices Magazine*, 19(2), 15-51.

[38] Tinto, V. (1993). *Leaving College: Rethinking The Causes and Cures of Student Attrition*, Chicago: The University of Chicago Press.

[39] Treuer, P., & Belote, L. (1997). Current and emerging applications of technology to promote student involvement and learning. *New Directions for Student Services*, 78, 17-30.

[40] van Grinsven, C. C. M. (2003). *Krachtige leeromgevingen in het middelbaar beroeps onderwijs: effect op motivatie en strategiegebruik bij zelfregulerend leren?* [*Powerful learning environments in secondary vocational education?*]. Unpublished dissertation, University of Leiden.

[41] van Grinsven, L., & Tillema, H. (2006). Learning opportunities to support student self-regulation: comparing different instructional formats. *Educational Research*, 48(1), 77–91.

[42] Winnips, K. (2000). *Scaffolding-by-design: A model for WWW-based learner support*, Enschede: University of Twente Press.

[43] Wu, T. Y. (2000). Integrative curriculum planning in technological and vocational education in Taiwan, Republic of China. San Diego, California: Paper presented at the Annual Conference of the Association for Career and Technical Education.

[44] Zaichkowsky, J. L. (1985). Measuring the Involvement Construct. *Journal of Consumer Research*, 12(3), 341-352.

[45] Zimmerman, B. J., Bonner, S. & Kovach, R. (1996). *Developing Self-Regulated Learners: Beyond Achievement to Self-Efficacy, Washington, DC: American Psychological Association.*

[46] Zimmerman, B.J., & Schunk, D. H. (1989). *Self-Regulated Learning and Academic Achievement: Theory, Research, and Practice*, New York: Springer-Veriag.