

Learning Effectiveness in Web-based Technology-mediated Virtual Learning Environment

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Abstract

A framework that delineates the relationships between learner control and learning effectiveness is absent. This study aims to fill this void. Unlike previous research, this study compares the learning effectiveness between two learning environments: traditional classroom and Technology-mediated Virtual Learning Environment (TVLE). Our work focuses on the effectiveness of a TVLE in the context of basic information technology skills training. Grounded in the technology-mediated learning literature, this study presents a framework that addresses the relationship between the learner control and learning effectiveness, which contains four categories: learning achievement, self-efficacy, satisfaction, and learning climate. In order to compare the learning effectiveness under traditional classroom and TVLE, we conducted a field experiment. Data were collected from a junior high school of Taiwan. A total of 210 usable responses were analyzed. We identified four results from this study. (1) Students in the TVLE environment achieve better learning performance than their counterparts in the traditional environment; (2) Students in the TVLE environment report higher levels of computer self-efficacy than their counterparts in the traditional environment; (3) Students in the TVLE environment report different levels of satisfaction than students in the traditional environment; and (4) Students in the TVLE environment report higher levels of learning climate than their counterparts in the traditional environment. The implications of this study are discussed, and further research directions are proposed.

Key words: Learner control; Technology-mediated Virtual Learning Environment (TVLE); Effectiveness

1. Introduction

While in an educational institution, the pace of transformation in a web-based environment may not have been as dramatic as that in industry; education has not been immune to internet-driven change (Beller and Or 1998,

Kiser 1999). The mode of education faces major changes due to the easily accessibility of web-based technology. TVLEs are defined as "computer-based environments that are relatively open systems, allowing interactions and knowledge sharing with other participants and instructors" and providing access to a wide range of resources (Wilson 1996). The value of a TVLE is to fully bring out the characteristics of both "Learning Any Where" and "Learning Any Time," i.e., learning in an asynchronous way. The purpose of a TVLE is to emphasize on self-control, diffuse thinking models, diverse viewpoints, and independent thinking (Hill & Hannafin, 1997).

Proponents of TVLEs argued that they can potentially eliminate the barriers while providing increased convenience, flexibility, currency of material, student retention, individualized learning, and feedback over traditional classrooms (Hackbarth 1996, Kiser 1999, Massy and Zemsky 1995). Although much of the literature emphasized the potential value of web technology in educations, others specified its drawback (Hara and Kling 2000). Students in TVLEs may have feelings of isolation (Brown 1996), frustration, anxiety, and confusion (Hara and Kling 2000). According to Maki et al's (2000) research, learner's learning effectiveness and interest in the subject matter may also be reduced.

Students are the primary participants in any learning environment. The main characteristic that differentiates between TVLEs and the traditional learning environment is the use of technology and shift of control and responsibility to the learners. Since the impacts of student-centered on learning effectiveness are not clearly specified in previous research, this study aims to identify these impacts. Drawing on technology-mediated learning theory (Alavi et al. 1995, Leidner and Jarvenpaa 1995, Piccoli et al. 2001), we developed a conceptual framework that identifies the primary dimensions of a TVLE and their relationships to learning effectiveness. We then conducted an experiment design that reports the results of a preliminary test of a subset of the relationships identified by the framework. We limit our inquiry to basic information technology skills, although our

conceptual framework has broader utility. We compared a TVLE to a traditional classroom-based course designed to introduce students to the fundamental concepts of computing principles and user skills. Since basic IT skills are obsolete very fast and the growing

2. Theoretical Development

Learner control

Learner control refers to “instructional designs where learners make their own decisions concerning the aspects of the path, flow, or events of instruction.” (Williams 1996) In other words, the learner can decide to a certain extent that students exert control over the pace, sequence, and content of instruction in a learning environment (Milheim and Martin 1991). Content represents the instructional material presented to the learner. Learning pace refers to the rate of presentation of the content and the time spent on individual component of content. Sequence stands for the representation order of the content that is accessed by learners (Milheim and Martin 1991).

The underpinnings of learner control contain three different types of theory—motivation theory (Keller 1983), attribution theory (Martin and Briggs 1986), and information processing theory (Gagne 1997). Proponents of learner control argued that students achieve better performance due to higher degrees of learner control. Performance is measured as lower errors on tests and higher learning satisfaction (Merrill 1994). Williams (1996) suggest that learner control may lead to positive results, because learner control is a way of allowing individual influences to exert a positive influence without trainer control.

Although the positive effect of learner control seems to appeal to most students, empirical findings remain inconclusive. Some studies show either the superiority or inferiority of learner control to traditional program control, but with the majority of the research indicating no significant difference between them (Reeves 1993, Williams 1996). Since individuals differ in their ability to make appropriate learning and instructing decisions, some learners may view less material and skip important instructional components due to the overestimation of their ability (Lepper 1985, Lee and Wong 1989, Reeves 1993).

Component display theory (CDT)

Component display theory (CDT) (Merrill 1983) is a theory of instructional design that offers the guidelines of designing presentation forms as the basic components of a lesson. We adopted CDT as the design criteria for both the TVLE and traditional learning environment. Merrill (1983, 1994) specifies four major presentation forms: (1) rule: the fundamental rationale for a specific instructional method or a model of learning. For example, the objectivist or traditional model views learning as the transfer of knowledge to

needs for academic and business environments, we choose to focus on basic IT skills.

the learner; (2) example: illustrations and explanations that specify the characteristics of a rule; (3) recall: remind students of the generality of the learning model and (4) practice: to combine theory with practice by taking instances. In order to provide a student with a full range of learning and instructional tools, the presentation of each instructional component should contain all of the above forms. As a result, learners may decide the learning pace, the sequence of presentation, and the control over content. According to Merrill’s theory (1983, 1994), when a course and its presentation form are designed based on CDT, it is assumed that students may have higher learning achievement provided that they have higher levels of learner control.

Learning Effectiveness

In order to understand the impact of learner control on students’ achievement, four antecedents of learning effectiveness in the TVLE are employed. First, according to Merrill’s research (1983, 1994), the number of errors on an achievement test following instruction represent one type of learning effectiveness. Since learners vary in their ability to gauge their progress and take advantage of a high level of control (Milheim and Martin 1991), learner control should be accompanied with aids for self-monitoring of progress (Williams 1996). In TVLEs environment, self-monitoring of progress can be easily fulfilled through practice assignments and discussions. Thus, we have the first hypothesis:

H1: Students in the TVLE achieve higher test scores than their counterparts in the traditional learning environment.

The second indicator of learning effectiveness is computer self-efficacy. Based on Bandura’s (1986) definition, self-efficacy refers to people’s judgments of their capabilities to attain designated types of performance. The main concern of self-efficacy is the judgments of what one can do with whatever one possesses. In the context of IT basic skills training, it is very important to evaluate the learners’ propensity to actually apply what they have learned. In addition, students’ confidence of their capabilities to employ IT appropriately is also an indicator of computer self-efficacy. Compeau and Higgins (1995) defined computer self-efficacy as learner’s judgment of his/her ability to complete a task using computers.

According to Keller’s (1983) model of motivational instructional design, learner control usually enhances students’ self-efficacy. Drawing on attribution theory, Martin and Briggs (1986) suggest that students, who have

more control over their instructional material, pace, and sequence usually ascribed the learning achievement to their own ability. As a result, learners who have more control of learning tend to feel that they can develop higher self-efficacy.

H2: Students in the TVLE will report higher levels of computer self-efficacy than their counterparts in the traditional learning environment.

Third, satisfaction has been a widely employed indicator to evaluate learning effectiveness both in academic and industry (Alavi et al. 1995). The success of TVLEs may depend heavily on learners' acceptance of this new type of learning and instructing methods. Since previous experience is an important determinant of future attitudes (Eagly and Chaiken 1993), it is essential to evaluate students' learning satisfaction with the innovative way to learn in TVLEs. According to CDT (component display theory)(Merrill 1983) and the general control theory (Piccoli et al. 2001), higher degrees of learner control may increase student satisfaction (Merill 1983, Williams 1996). With the help of TVLEs, students may participate in learning activities more flexible than in the traditional learning environment. Learners decide when and where they prefer to learn at their own pace, and to focus on the content that they deem important. As a result, students' satisfaction tends to increase.

However, Williams (1996) argued that learners may feel frustrated due to the feelings of unable to receive effective and timely advices from instructors in TVLEs environment. According to Maki et al's (2000) research, the students in the traditional learning environment have higher levels of satisfaction with learning experience than in TVLEs. When individuals are confronted with a learning environment that employs a new technology and high level of learner control, they tend to have negative attitudes. Although these negative attitudes from learners lessen gradually, they do not entirely disappear (Wetzel et al. 1994). Because the perspectives concerning the satisfaction in TVLEs and traditional classroom differ radically, we have the third hypothesis:

H3: Students in the TVLE will report different levels of satisfaction than their counterparts in the traditional learning environment.

Finally, the emotional learning climate is also an important indicator of learning effectiveness. Some learning theories view learning as a social process that occurs more effectively through cooperative interpersonal interactions (Alavi et al. 1995). According to Vygotsky's (1978) research, learning is composed of social and knowledge exchanging activities that initially shared among people but finally internalized and personalized by the individual. Piaget (1967) contends that the main purpose of social interactions is to shifting an individual's thinking

away from an egocentric perspective. While the learner possesses multiple perspectives that can challenge his/her initial understanding of a specific problem, the learner's motivation for learning is usually enhanced (Glaser and Bossak 1989). In TVLEs, the learning process contains a lot of interactions and knowledge exchange among learners and between learners and instructors.

Group interactions for learning and knowledge sharing consist of socio-emotionally focused processes (Dennis and Valacich 1994). More specifically, based on McGrath's (1991) TIP theory—Time, Interactions, and Performance--group interactions contain three critical and concurrent functions—production, member support, and group well-being. Production function stands for the task formally assigned to a group. The purpose of group interactions is to solve a problem or learn a skill or concept, i.e., to complete the production function. Member support contributes to the satisfaction of individual members. Group well-being contributes to the group's emotional climate and viability as an intact social structure (Alavi et al. 1995). In the light of TIP theory, both socio-emotional and task-oriented behavior is operated simultaneously in TVLEs learning environment. Thus, from the group interactions perspective, the measurement of learning effectiveness consists of three important factors—learning achievement (the production function), satisfaction (member support), and the perception of the emotional climate of the group or learning environment (group well-being).

According to media richness theory, an environment that conveys information and matches up to the learners' expectations will usually improve the group task performance and emotional climate. In TVLEs, learners can control the learning pace, sequence, and content. In comparison to the group interactions in the traditional environment, it seems easier for learners to reduce the uncertainty and equivocation in the TVLE, because they may ask experts or classmates to help them through communication media. Thus, we have the final hypothesis:

H4: Students in the TVLE will report more positive learning climate than their counterparts in the traditional learning environment.

3. Research Design

Figure 1 identifies the basic components of our research framework. The basic research question is: what is the impact of learner control on learning effectiveness? Data were collected from a junior high school of Taiwan—Hsing-Kuo Junior High School (HKJHS). We employed a ten weeks field experiment adopting a two group repeated design—TVLEs and traditional learning environment. A total of 210 students that are their first year in HKJHS participated in

the experiment. 107 of the 210 students joined the treatment group, the others (N= 103) belonged to control group. Subjects did not have prior knowledge of the selected course. Subjects were the representatives of the traditional junior high school population. They were young (age = 13.88%), and fairly evenly distributed by gender (58.2% males, 41.8% female). The course is an introductory course regarding computer software package.

In a preliminary survey, we measured demographics. Three traits of learner were examined: attitudes toward computer use, previous experience with computers, and anticipation of the course. We also conducted a quiz to test the learners' basic knowledge of the course material. A series of t-tests indicate no significant difference between the treatment and control group on these dimensions. Thus, we assume the homogeneity of pretreatment skills, attitudes, experience, and expectation.

Four sections of the target course were offered. Two of the sections belonged to the treatment groups, and the others were assigned to the control group. Two instructors participated in the experiment, and each of them taught one section in the traditional classroom and one section in the TVLE. In the traditional classroom, the teacher instructed and demonstrated specific software features. Instructors employed an overhead projector and assigned standard homework to students every week.

The TVLE was developed using "Ed Pilot interactive online system," which contains three layers to facilitate the creation and administration of online courses—the courses browser for both students and teachers, courses development tools for teachers, and the courses server for the system manager to administer the system. The TVLE is an open system to allow learners and instructors interacting through an electronic forum. Learners and instructors that participated in the class electronic discussion can make comments, raise questions, and responses in an asynchronous fashion. The forum is publicly available to all users in TVLE, and the discussion can be threaded. Therefore, learners can easily access and read the information on different subjects. In addition, due to the threading of public communication, students can selectively retrieve the information and components that are interesting to them while skipping the others. As a result, students can control the learning content, pace, and sequence.

The major difference between the two learning environments is the higher level of learner control provided by TVLE. In the TVLE, the learning is more flexible. Students can access the instructional material at any time and from any place equipped with the necessary software and hardware.

4. Data Analysis and Results

4.1 Validity and reliability

Factor analysis using principal components factor analysis with factor extraction and VARIMAX rotation was conducted to examine the unidimensionality/convergent and discriminant validity. The four commonly employed decision rules were applied to identify the factors (Hair et al. 1995): (1) minimum Eigen value of 1; (2) minimum factor loading of 0.4 for each indicator item; (3) simplicity of factor structure; and (4) exclusion of single item factors. Reliability was evaluated by assessing the internal consistency of the indicator items of each construct by using Cronbach's α , which is shown in Table 3 (see Appendix A). The results of factor analysis relating to unidimensionality/convergent validity are shown in Appendix A. A joint domain factor analysis was performed, including all of the items used to develop the research constructs. The result provides significant support for factorial/discriminant validity of the measurement scales (see Table 1 and 2 in appendix A).

4.2 Hypotheses test

Grades on midterm and final exams were adopted to measure student's achievement. Computer self-efficacy, satisfaction, and learning climate were measured through validated scales (Alavi et al. 1995, Compeau and Higgins 1995, Green and Taber 1980). Respondents were asked to indicate on five-point scales ranging from (1) strongly disagree to (5) strongly agree. The results of factor analysis and reliability relating to learner traits, leaning effectiveness, and learner's self-report are shown in Table 1 and 2 in Appendix. As indicating from these tables, all items loaded in the expected construct. As can be seen from Table 3, the reliability of the measures is at a satisfactory level.

Tests of the assumption of homoscedasticity and normality underlying repeated measure designs (Hair et al. 1995). Mean and standard deviations of learning achievement, self-efficacy, satisfaction, and climate are reported for both TVLE and traditional environments in Table 4 and 6. We employed "independent samples T test" to compare the different types of learning effectiveness between TVLE and traditional learning environments. As shown in Table 4, the grade of total—midterm and final exam—in TVLE (84.67) is higher than that of in traditional environment (81.48). Thus, hypothesis 1 is substantiated. In order to examine whether the pattern of learner's achievement differed between the first and second data collections (i.e. midterm and final), we adopted "Pair-samples T-test." From Table 5, the results show that no performance difference exists between the two data collections in the TVLE. However, students have lower final grades than their midterm grades in the traditional environment, and the difference is statistically significant.

The results of Table 6 suggesting the learning effectiveness-- self-efficacy (Sig. = 0.011*), satisfaction (Sig. = .011*), and climate (Sig. = .000**)— in TVLE is better significantly than in the traditional learning environment. Therefore, hypothesis 2, 3, and 4 are all substantiated. The summary of our hypotheses test is shown in Table 7.

5. Limitations

There are two limitations in this study. First, we did not analyze the relationship between time spent in the TVLE and computer self-efficacy. Students in the TVLE usually spend more time interacting with computers and IT. Thus, the main reason for high computer self-efficacy in the TVLES is probably not due to the learner control. Instead the high computer self-efficacy is because of the time and interactions that the learners spent. Second, we selected basic computer skills as the subject used in the current study. Because basic computer skills is a subject that highly relates to the employing of information technology. Replications concerning other subjects seem critical to generalize our results.

6. Conclusions and Implications

TVLEs offer popular learning environments due to the convenience and flexibility, but their effectiveness remains an open question (Kiser 1999, Milheim and Martin 1991). Drawing on virtual learning environment and technology-mediated learning theory, we developed a conceptual framework that identifies the major dimensions of a TVLE and their relationship to learning effectiveness. We then conducted empirical studies to exam our research framework. We identify four criteria—learning performance (test grades), computer self-efficacy, satisfaction, and learning climate-- to represent the effectiveness of a learning environment based on previous research (Alavi et al. 1995, Compeau and Higgins 1995, Vygotsky 1978, Williams 1996). Our findings suggest that students learning basic IT skills in TVLEs have better learning effectiveness than their counterparts in traditional classrooms. These findings support the studies conducted by Keller (1983) and Williams (1996), but are not consistent with the argument proposed by Russell (1999) concerning technology-mediated learning.

Our experiment employed virtual learning tools that combine audio, video, on-line interactions with students or instructors, and the connection with instructional material and other learning sites. According to Alavi et al's (1995) research, studies that evaluate learners' behavior and learning effectiveness in relation to new learning environments must always consider the impact of novelty on the measured criteria. The effect of adopting a novelty technology may be transitory in nature and not an enduring outcome. Since the effect of learning may due to the novelty of

adopting a new technology, our field experiment lasted for 15 weeks to minimize the transitory effects. Because TVLEs provide high level of learner control, coupled with aids for self-monitoring of progress, the students in the TVLEs outperform their counterparts in the traditional environment. The test scores of students in the TVLEs are higher. In addition, from Table 5, there is no performance difference in TVLEs between midterm and final, while the performance becomes lower in the traditional environment. This finding indicates that the performance is not due to the transitory effects of novelty. Thus, it is reasonable to suggest that learning in the virtual environment is beneficial from a performance point of view.

TVLEs are the learning environments unfamiliar to most students who need to develop appropriate learning strategies (Jonassen 1985). However, with the help of easy to use browse, as well as high quality and reliability of technology, TVLEs may facilitate the gathering of information. An electronic forum in TVLEs with discussion board technology enables rich interactions. Instructors may use it to quickly and publicly answer student questions, and also promote asynchronous discussion. Students may access different knowledge sources to explore a subject, and engage in discourse and construction of meaning. As a result, students may attain both objectivist and constructivist learning model in TVLEs (Colins 1995, Piccoli et al. 2001). Based on the theory of motivational instructional design (Keller 1983, Martin and Briggs 1986), we expected high computer self-efficacy from learners because they have more control over the learning in TVLEs environment. Our results show students in the TVLE have higher computer self-efficacy. This seems to imply that higher learner control leads to higher computer self-efficacy. When students receive considerable guidance and instruction in TVLEs, they feel proud that they have the capability to use learning tools and learn independently. Once students have employed the instructional tools in TVLEs and learned independently, they feel that they could do it again in the future. Piccolli et al's (2001) research indicates that learners attribute the successful computer self-efficacy to their own effort and ability.

Subjects in TVLEs reported higher levels of satisfaction than their counterparts in the traditional environment. Our finding is consistent with prior studies regarding learner control and satisfaction (Merill 1983, Williams 1996). We have explained the positive effects of learner control on satisfaction in the hypothesis development section. We may ascribe this result to the capability of using a novel technology-intensive learning environment by learners who belong to the young generation (age \leq 13). Most learners were satisfied with the high technology quality and reliability provided by our virtual learning environment.

Subjects reported that the access speed was very fast and the interface was user-friendly. The aforementioned explanations seem to suggest that technological proficiency and the ability to rely on the community of learners through learning tools have positive effect on satisfaction (Brown 1996, Hara and Kling 2000).

Finally, our study supports the hypothesis that learner's emotional learning climate in the TVLE is higher than their counterparts in the traditional environment. One implication could be that the students in the TVLE are more willing to join the class due to the novel means of interacting with other students and instructors. TVLEs are open systems that allow for participant interaction through synchronous and asynchronous electronic communication. Due to the available learning and electronic communication tools in the TVLE, students can ask and answer questions, to post comments, and to participate in a knowledge sharing and exchange with peers and the instructor. As a result, students may have more chance to verbalize and articulate their current understanding. According to Collins's (1991) research, articulation processes facilitate learners to evaluate their understanding by making their decisions and problem solving strategies explicitly. The TVLE provides learners with tools to promote the expression of tacit knowledge and its reinterpretation into explicit knowledge. In addition, learners assess their progress and their instructional needs during self-paced learning. To summarize, it seems reasonable to assume that the high socio-emotional climate is due to the capability of facilitating group interactions and assisting learners in measuring their progress and instructional needs in our TVLE (Dennis and Valacich 1994, Milheim and Martin 1991, Steinberg 1989).

Our study did not investigate the impact of human dimension—individual traits of students—on learning effectiveness. Since the major difference between TVLEs and traditional classrooms is that the former shifts control and responsibility on learner, individual characteristics of learners may play a critical role in influencing learning effectiveness. Piccoli et al's (2001) study suggests that the ability to manage time and learning schedule, monitor personal progress, and communicate through electronic media belong to the category of learner' human dimension. We may also exam the influence of computer attitude, computer experience and course expectation in the future research (MacGregor 1999, Paolucci 1998).

Acknowledgements

We would like to acknowledge the comments from anonymous reviewers who have provided remarkable insights to improve the quality of this paper. This project was partially supported by National Science Council (NSC) of Taiwan

and the research center of Mobile Computing at NKFUST.

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Appendix

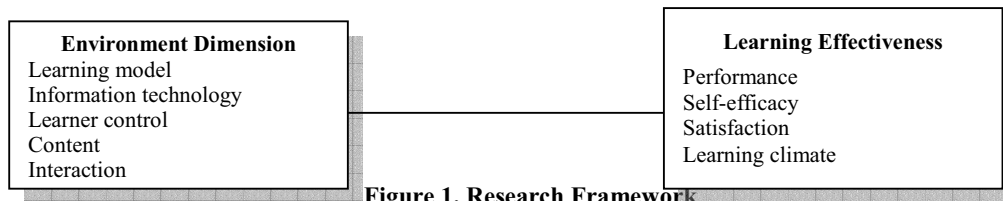


Table 1. Factor Analysis of Learning Effectiveness

Factor	Eigen Value	Variance	Cum Variance	Mean Std. Dev.	Factor Loading
Computer Self-efficacy	1.221	13.563	60.298	3.979 (0.796)	
1. I was confident to learn online on my own time.					.831
2. I was confident to learn online at my own pace.					.842
3. I was confident to get a good grade in the course.					.704
4. I improved learning by repeatedly reviewing the course materials.					.735
5. I connected to the online course from the place I chose.					.513
6. I chose the appropriate learning environment to improve learning achievement.					.710
7. I made the most of internet to grasp the learning materials.					.753
8. I felt anxious because of computer incompetence.					.927
9. I employed the online information to learn and to motivate learning.					.690
Learning Satisfaction	1.134	14.178	66.212	3.765 (0.869)	
1. I was satisfied with this learning experience.					.761
2. A wide variety of learning materials were provided in the course.					.763
3. I don't think that the course would benefit my learning achievement.					.971
4. I was satisfied with the immediate information acquisition.					.813
5. I was satisfied with the learning flexibility and independence of this course.					.820
6. I was satisfied with the instruction model.					.780
7. I was satisfied with the learning environment.					.753
8. I was satisfied with the overall learning effectiveness.					.693
Learning Climate	2.208	22.082	57.144	3.773 (0.959)	
1. The course was interesting.					.734
2. It was important to choose the place to learn.					.744
3. I felt free to ask questions.					.560
4. I had more interaction and communication with classmates.					.606
5. I had more interaction and communication with the instructor.					.678
6. I think this learning environment was more interesting.					.644
7. I felt less pressure about this learning model.					.648
8. This learning model was boring.					.655
9. The learning climate was relaxing.					.758
10. The learning climate was enjoyable.					.824

Table 2. Factor Analysis of Learner's Self-report

Factor	Eigen Value	Variance	Cum Variance	Mean Std. Dev.	Factor Loading
Computer Self-efficacy	1.261	14.010	64.971	3.716 (0.933)	
1. I was confident to learn online on my own time.					.755
2. I was confident to learn online at my own pace.					.859
3. I was confident to get a good grade in the course.					.711
4. I improved learning by repeatedly reviewing the course materials.					.721
5. I connected to the online course from the place I chose.					.612
6. I chose the appropriate learning environment to improve learning achievement.					.631
7. I made the most of internet to grasp the learning materials.					.845
8. I felt anxious because of computer incompetence.					.745
9. I employed the online resources to learn and to motivate learning.					.651
Learning Satisfaction	2.122	26.531	60.844	3.858 (1.018)	
1. The learning experience with the TVLE was better than that with the traditional classroom.					.824
2. A wide variety of learning materials were provided in the TVLE.					.856
3. I don't think that web-based learning would benefit my learning achievement.					.393
4. I was satisfied with the immediate information acquisition in the TVLE.					.739
5. I was satisfied with the learning flexibility and independence of the TVLE.					.648
6. I was satisfied with the web-based instruction model.					.807
7. I was satisfied with the TVLE.					.736
8. I was satisfied with the overall learning effectiveness in the TVLE.					.796
Learning Climate	1.926	19.256	69.476	4.015 (1.042)	
1. The course was more interesting in the TVLE.					.659
2. I was free to choose the place to learn in the TVLE.					.524
3. I felt free to post questions to the online discussion board in the TVLE.					.856
4. I had more interaction and communication with classmates in the TVLE.					.761
5. I had more interaction and communication with the instructor in the TVLE.					.749
6. I think the TVLE was more interesting.					.602
7. I felt less pressure about the web-based learning model.					.802
8. The learning climate in the TVLE was relaxing.					.803
9. The learning climate in the TVLE was enjoyable.					.769
10. The learning climate in the TVLE was boring.					.747

Table 3. Results of the Reliability Analysis

Construct	Variable	Cronbach's α
Learning Effectiveness	Computer self-efficacy	0.8276
	Learning satisfaction	0.8625
	Learning climate	0.8558
Learner's Self-report	Computer self-efficacy	0.7525
	Learning satisfaction	0.7638
	Learning climate	0.8719

Table 4. Means and Standard Deviations of Learning Performance

Variable (performance)	TVLE			Traditional Classroom		
	Midterm	Final	Total	Midterm	Final	Total
N	107	107		103	103	
Mean	84.15	85.18	84.67	84.52	78.44	81.48
Std. Deviation	10.42	8.32		10.98	11.08	

Table 5. Paired-samples T-test for Performance of Midterm and Final

Learning Environment	N	Std. Deviation	Correlation coefficient	df	T-value	Sig
TVLE	107	11.32	.286	106	-.939	.350
Traditional	103	10.30	.564	102	5.998	.000**

significance : ** p<0.05; * p<0.1

Table 6. Independent Samples T Test: Dependent Variables

		N	Mean	Std. Deviation	F	T-value	DF	Sig.
Computer self-efficacy	TVLE	107	35.87	5.06	2.021	2.577	208	.011*
	Traditional classroom	103	34.13	4.67				
Learning satisfaction	TVLE	107	31.10	4.55	0.722	4.424	208	.000**
	Traditional classroom	103	28.19	4.97				
Learning climate	TVLE	107	38.82	5.68	0.182	3.556	208	.000**
	Traditional classroom	103	35.93	6.10				

significance : ** p<0.05; * p<0.1

Table 7. Results of Hypotheses Test

Hypotheses		Method	Result	Reference
H1	Students in the TVLE will outperform their counterparts in the traditional environment.	Independent Samples T Test	Substantiated	Table 4
H2	Students in the TVLE will report higher levels of computer self-efficacy than their counterparts in the traditional environment.	Independent Samples T Test	Substantiated	Table 6
H3	Students in the TVLE will report different degrees of satisfaction than students in the traditional environment.	Independent Samples T Test	Substantiated	Table 6
H4	Students in the TVLE will report higher levels of learning climate than their counterparts in the traditional environment.	Independent Samples T Test	Substantiated	Table 6