
The Influence of Learning Styles on Learners in E-Learning Environments: An Empirical Study

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Abstract

The purpose of this study was to compare the effects of e-learning versus those of traditional instructor-based learning, on student learning, based on student learning styles. Another goal was to determine if e-learning is more effective for those with a particular learning style. The Kolb Learning Style Inventory (LSI) measured the learning styles of students. This post-test, intact-group design examined the dependent variable of student knowledge based on the learning style of each subject and the learning method to which each was exposed. The results revealed that for the instructor-based learning class (traditional), the learning style was irrelevant, but for the web-based learning class (e-learning), the learning style was significantly important. The results indicated that students with the Assimilator learning style (these learn best through lecture, papers and analogies) and the Converger learning style (these learn best through laboratories, field work and observations) achieved a better result with the e-learning (web-based) method.

Introduction

As we enter the third millennium, education via the internet, intranet or network represents great and exciting opportunities for both educators and learners. Educators have witnessed the rapid development of computer networks and improvement in the processing power of personal computers. In addition, the internet and World Wide Web (WWW) have made the computer a dynamic force in distance education, providing a new and interactive means of overcoming time and distance to reach learners (Wagschal, 1998). Electronic learning

(e-learning) is an evolving, dynamic and rapidly changing educational opportunity that is a product of the advanced information technology environment. E-learning is essentially the network-enabled transfer of skills and knowledge (Anon, 2006). The internet is the largest, most powerful computer network in the world. It encompasses several million computers with internet addresses that are used by millions of people around the world. As increasingly more colleges, universities, elementary and secondary schools, companies and private citizens connect to the internet, more possibilities are opened for distance educators to overcome time and distance to reach students. Through the internet, all sources of information on different subjects are available any time, anywhere.

In 1997, large leading-edge firms delivered 21% of their training via learning technologies, with 70% as instructor-led courses (Bassi and Van Buren, 1998). Very soon, the percentage of training time delivered by learning technologies such as the internet and e-learning is projected to grow much more. It is expected that e-learning will soon play a greater role at the higher education level, as well as middle and primary school levels, and non-formal education will become one of the main functions of e-learning (Zenaida, 2004).

E-learning

E-learning refers to using electronic applications and processes to learn. E-learning applications and processes include web-based learning, computer-based learning, virtual classrooms and digital collaboration. Content is delivered via the internet, intranet, extranet, satellite TV, and CD-ROM with multimedia capabilities (ISP, 2004).

E-learning is defined as individualised instruction delivered over public (internet) or private (intranet) computer networks. E-learning is also referred to as online learning, web-based learning (WBL) and the virtual classroom. E-learning was first called 'internet-based training' then 'web-based training'. Today you will still find these terms being used, along with variations of e-learning (Jugon, 2003).

Technology is much more than computers in the classroom. According to Lovelace (1999) there are two types of e-learning : asynchronous or self-paced, and

synchronous or instructor-led. The degree of interactivity, sophistication and expense is different in each of the types. E-learning is not traditional computer based learning (CBL). Neither is it downloaded to a hard drive like CBL; rather, it is stored on a server and accessed over a network by a web browser. E-learning programs are saved on the internet/intranet and can be accessed any time, anywhere, regardless of the computer platform, as long as the user has subscribed to an internet service provider (ISP).

In a web-based environment, instructors can create a hypertext link to connect the student to, for example, Wall Street, to experience stock trading with the guidance of the instructor. E-learning is backed by the WWW and therefore has access to virtually unlimited information. The reach of information in CBL is limited. Even large storage media have a finite capability to store information. Web-based learning is worldwide accessible, low in maintenance, secure, platform-independent, always current and can accommodate various learning styles. Educators and students are using the web in a variety of ways to enhance their teaching and learning experiences. E-learning can be delivered to the learners easily, in an individualised manner.

Learning styles

Individual learning styles differ, and these individual differences become even more important in the area of education. Therefore, the real challenge in e-learning is keeping the people it is designed for in mind (Canavan, 2004). Learning style is defined as an individual's inherited foundation, particular past life experience and the demands of the present environment that emphasise some learning abilities over others (Kolb, Rubin and McIntyre, 1974). Educators should be aware of how people obtain and preserve skills and how they access information to help their progress. Hiltz (1993) indicates that a primary goal in studying a new medium of communication for educational delivery must be the identification of its impact on learning. Students may benefit from understanding their own learning style by taking measures to adjust the way they acquire knowledge (Cowley *et al.*, 2002).

While instructors cannot always accommodate each student's need, it is important that several learning opportunities are provided (Tu and McIsaac, 2002). It is expected that when the learning experience is more effective for the student, an increased level of user acceptance of information systems will result.

Researchers believe that learning style is a good predictor of an individual's preferred learning behavior (Bostrom, Olfman and Sein, 1993). Lindsay (1999) found that a match between learning style and teaching style reveals increases in student achievement and satisfaction.

Contrary to these findings, Hajizainuddin (1999) found no significant relationship between the information-processing characteristics of learning style and performance. In addition, he found no significant interaction among the factors of learning style, hypermedia's organisational structure and attitude. Desai (1996) indicated that learning style does not significantly influence a subject's learning.

While there is plenty of study done on learning styles, there does not seem to be any agreement or approval of any one theory (Bruen and Conlan, 2002). Furthermore, not all researchers and writers agree with learning style models. A research report from the Learning and Skills Research Center (Coffield *et al.*, 2004) studied many influential learning style models and did a critique of all experimental learning style theories. This research questions the reliability, validity and implication of learning styles in general. In addition, the authors have criticised some of the research that has used these models including the Kolb's learning style model and disagreed with the way they came to their conclusions. According to the paper, Kolb's Learning Style Inventory (LSI) in general 'should not be used for individual selection'. Referring to the validity and reliability of LSI the paper indicated that 'the construct validity of the LSI has been challenged and there is a long public dispute over reliability of LSI'. Furthermore, the paper indicated that, there is no proof that 'matching' increase educational performance in future education and that the findings are inconsistent and questionable.

Markham (2004) points out that the research on learning style has to go further than the simplistic effort to show that people differ on a measure and that these differences lead to a definable learning outcome.

Need for the study

E-learning has already influenced the field of teaching, training and development. A growing number of college courses are delivered over the web and are increasing student numbers (Chang, 2001). Many directors of corporate training believe that web-based learning is the future method for their training programmes (Barron, 1999). However, the field lacks enough documentation to show that e-learning is an effective delivery mechanism in relation to the individuals being taught. For example, research on learning styles has consistently shown that considering personality attribute in preparing and delivering instruction can significantly improve the learning process (Dwyer, 1998). Aroyo and Dicheva (2004) indicate that many researchers in the area of education systems are concerned with moving their research to a coherent space of collaborative intelligence from scattered intelligent. There are only a few practical studies that have investigated the effect of this methodology on student knowledge when considering learner's learning styles.

This research empirically investigated the impact of e-learning on student knowledge based on learning styles. In addition, this study attempted to provide evidence that e-learning is more effective for those with a particular learning style. Results were compared with the traditional instructor-led course format. The outcome of this study should help instructors and instructional designers to develop more efficient and effective instructional methods based on student learning styles. Furthermore, the outcome of this study could help training and learning centres look for efficient and effective methods to keep up with the ever-growing need to upgrade the skills of their workforce based on their learning styles.

Participants

The study examined undergraduate students at a major university who were enrolled in a subject course that was offered as an on-campus instructor-based (traditional) option and a web-based (e-learning) option. For this study, students of only one instructor were involved. The instructor taught both the web-based class and the instructor-based class in two different sections. Therefore, the possibility of interaction between the methodology and having different instructors was minimised. All students participated in the knowledge exam on the same day.

Instrumentation

The Kolb LSI was used to measure the learning styles of students. Kolb's learning styles are defined by four levels: Diverger, Assimilator, Accommodator and Converger (see Table 1).

Table 1. Features of learning styles

Learning style	They best learn through
The Diverger	Feeling and watching
The Assimilator	Thinking and watching
The Converger	Thinking and doing
The Accommodator	Feeling and doing

The LSI is well respected and used in business organisations and academia. It is designed to measure the degree to which individuals display the learning styles derived from experiential learning theory. The LSI requires students to resolve the tension between the abstract-concrete and active-reflective orientations. For this reason, the LSI format requires respondents to rank-order their preferences. It was hoped that the measures of learning styles would predict behaviour in a way consistent with the theory of experiential learning (Kolb *et al.*, 1974). The LSI, in conjunction with the teaching strategy, comprised the independent measures. The performance measure that was investigated in this study as a dependent measure was the knowledge gained at the end of the semester for each method of learning.

The LSI test, a 12-item questionnaire in which respondents attempted to describe their learning style, was first given to the students three weeks before they took the exam. Finally, students took the end-of-semester, knowledge-based, comprehensive exam.

Data analysis

The data were translated into an ASCII database file and placed on a floppy disk. They were analysed using SPSS version 10.0. Based upon the results of the LSI and post-learning exam, a series of two-way analysis of variance (ANOVA) techniques and independent variable tests were used for the dependent variable, knowledge based on a student's learning style.

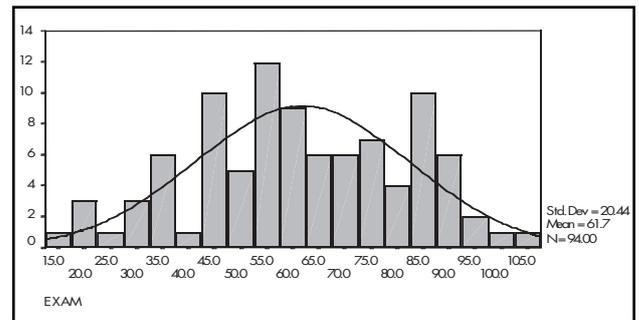


Figure 1. Distribution of subjects' knowledge exam

To determine if any difference existed between the two groups, an analysis of student knowledge (final exam grade) for both groups was done.

Student knowledge exam (dependent variable)

Subjects took a knowledge-based exam at the semester's end to investigate how learning was impacted owing to the learning methods. The science department, with the instructors' help, created the end-of-course exam, which was the same across both sections, whether the students enrolled on the web-based or instructor-based option. The comprehensive exam consisted of 21 questions with few sub-questions and had a two-hour time limit. Figure 1 shows the distribution of subjects' knowledge exam. The $N = 94$ is the total number of students who took the exam. Standard deviation is 20.44 and mean is equal to 61.7 for the knowledge-based exam.

Results

A two-way ANOVA procedure was conducted, involving two independent variables. The first independent variable was Kolb's learning style categories and the other was learning methods. Kolb's learning styles are defined by four levels: Diverger, Assimilator, Accommodator and Converger. The learning method was made up of two levels: e-learning and traditional learning. The student knowledge was analysed in a 4 by 2 ANOVA.

Table 2, a two-way ANOVA summary, provides three F values. These three F values are associated with three research questions. The following are the three independent research questions that were tested in terms of the relationship between methods of instruction and knowledge gained by students during the semester. In addition, the interaction effect of methods of learning and student learning styles on the same dependent variables was tested.

1. Is there a statistically significant main effect for the learning style?
2. Is there a statistically significant main effect for the learning method?
3. Is there a statistically significant interaction between the learning style and learning method?

These three research questions deal with learning style and learning method at the same time. Two main effects and one interaction effect were assessed.

Table 2. Summary of ANOVA for student knowledge

Source	SOS	df	MS	F	p	η^2
LS	3299.24	3	1099.75	2.74	.048	.085
LM	96.63	1	96.63	.24	.625	.002
LS*LM	1961.08	3	653.69	1.63	.189	.050
Error	34530.11	86	401.51			
Total	38863.66	93				

Note: SOS = sum of square; df = degree of freedom; MS = mean square; F = computed F value; p = level of significance.

The first F value is concerned with the main effect, which dealt with the learning styles. The two-way ANOVA, with student knowledge (grade score) identified correctly as the dependent variable, yielded a significant main effect for learning style [$F(3,86) = 2.74, p = 0.048$ in which $p < 0.05$]. This means that learning style main effects are statistically significant in the student knowledge grade. Therefore, based upon the data collected and analysed in Table 2, there was a significant difference in student knowledge based on learning styles when learning on the web versus instructor-led. The other two sources, learning methods and interaction of learning styles and learning methods, were not significant as the F value is greater than 0.05 ($p > 0.05$).

The e-learning mean was 60.78 ($SD = 22.59$) and the IBL mean was 62.28 ($SD = 19.18$); see Table 3. The means and standard deviations for both groups were not significantly different, giving some confidence that they represented the same population. At the same time, this finding confirms earlier findings that delivery strategy does not significantly impact student outcome. If this is true, then the use of web-based strategies should be based on other factors. There was no significant interaction between learning style and teaching methodology, but it is possible a larger sample could have shown significant differences.

Figure 2 show that the students with learning styles one (Assimilator) and four (Converger) did better with the e-learning or web-based learning style. In addition, students with learning styles two (Diverger) and three (Accommodator) received better results with traditional instructor-based learning.

Table 3. Means and standard deviation of student knowledge based on e-learning and instructor-based learning (IBL)

Learning method	Student knowledge	
	M	SD
IBL	62.28	19.18
e-learning	60.78	22.59

Note: M = mean; SD = standard deviation.

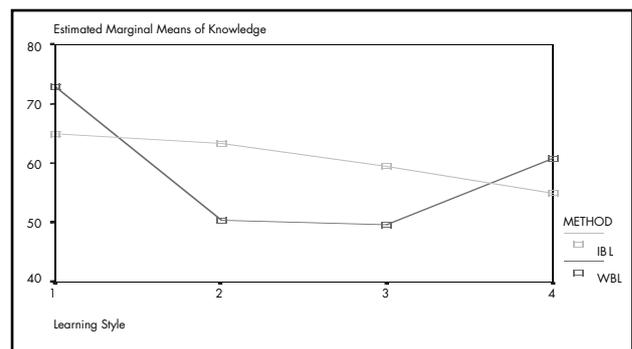


Figure 2. Interaction effects of learning style and learning method on student knowledge

Note: Learning style 1 = Assimilator; 2 = Diverger; 3 = Accommodator; 4 = Converger.

Conclusions

The results of this research paper revealed that students' learning styles were statistically significant for knowledge performance. This conclusion is consistent with earlier findings on the importance of learning style. For the instructor-based learning class (traditional), the learning style was irrelevant, but for the web-based learning class (e-learning), learning style was significantly important. The results showed that students with learning styles Assimilator (these learn best through lecture, papers and analogies) and Converger (these learn best through laboratories, field work and observations) did better with the e-learning method. This mean that those learners that like to learn through thinking and watching and thinking and doing would learn better with e-learning . In addition, students with learning styles Accommodator (these learn best through simulations and case study) and Diverger (these learn best through brainstorming and logs) received better results with traditional instructor-based learning.

In other words, with the Assimilator and Converger learning styles there was a slight increase in score performance as the method of delivery changed. Staff in charge of curriculum development, and corporate leaders, will have to motivate their learners to use e-learning as a formal learning and training tool. The result of this study could be of specific interest in educational foundations and training institutes; in particular those that want to transfer some of their conventional courses onto the web.

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