Alternative Learning Approaches for Electronic Learning Environments in Smart Schools: Survey Results

Kemalatha Krishnasamy[1], Sai Peck Lee[1], and AnandaKumar Palaniappan[2]
[1]Faculty of Computer Science and Information Technology, University of Malaya, Malaysia
[2]Faculty of Education, University of Malaya, Malaysia

Abstract: *Learning styles have been studied for many years; however, studies focusing on learning styles based on multiple intelligences theory for electronic learning are very limited. Knowledge of learning styles is important and may be useful in the development and conduct of e-learning in higher learning institutions and schools. The purpose of this study was to establish baseline information regarding the distribution of learning styles among lower secondary students at selected smart schools in Malaysia. A secondary purpose was to establish for these same individuals their stated preferred learning mode for learning online. A purposive sample (judgment sampling) was developed with permission from Ministry of Education and Education Departments in Malaysia. The learning style for each respondent was determined using the multiple intelligences inventory. The results of the study showed that, web-based instruction in its present form was more preferred by students whose intelligences were visual/spatial and interpersonal. Verbal/linguistic and logical/mathematical students reported less benefit from e-learning, perhaps because these students were more oriented towards traditional classroom learning.*

Keywords: *E-learning, online teaching and learning, multiple intelligences, effective design*.

Received November 5, 2004; accepted February 21, 2005

1. Introduction

A shift from a traditional to a progressive model of education has led to an increased interest in learners' individual differences. The new paradigm is student-centered, inclusiveness, cooperative learning, which encourages diversity. Furthermore, technology is seen as having the potential to enhance the capabilities of the learner and the teacher [2]. Several earlier studies attempt to correlate learning styles and computer/Internet related activities; however none to our knowledge related multiple intelligences and e-learning preferences. For example, Montgomery [13] asserts that multimedia can be used to address learning styles more effectively than traditional teaching methods. The study revealed that students with different learning styles had preferences for different types of multi-media. Addressing different learning styles through hypermedia courseware has been found to enhance student learning. Carver [3] developed a selection of WWW based tools designed to enhance learning and to address a variety of learning styles based on Felder's model.

Education is not the only discipline where interaction between learning styles and computers are studied. The field of Human-Computer Interaction (HCI) is also actively researched. Elsayed-Elkhouly [4] examined how information can be presented in ways which conform to users' learning styles in order to improve the quality and usability of human-computer interface mechanisms. One of the most important issues surrounding the question of learning styles theory in relation to e-learning is whether learning styles significantly affect learning outcomes. Leuthold [11] in her studies has tested the hypothesis that a person's underlying learning style is a useful predictor of their attitude toward computer-based instruction and learning. Perniu *et al*. [14] investigated how instructional materials in a chemical course could be tailored for different learning styles. This study focused on students' learning preferences for perception, presentation, organization, processing and assimilation of information. In contrast to Perniu *et al*.'s paper, Pimentel [15] explored the relationship between virtual learning environment and learning styles. Zywno & Waalen [17] conducted Quasi-experimental study to examine the influences of learning styles based on Felder-Solomon index on academic performance in two types of learning environments; hypermedia assisted and conventional learning. The paper highlights that, largest increases in achievement were found among students with active, sensing and global learning preferences. These students also expressed the highest rate of approval for the hypermedia instruction and supplemental web materials. However, there was no significant difference

in web usage patterns between students with different learning styles.

Multiple Intelligences (MI) theory was first proposed by Howard Gardner book, *Frames of Mind: The Theory of Multiple Intelligences* [5]. Since that time, educators have become interested in the theory as a means to improve teaching and learning in multiple ways. The theory represents a particular orientation towards the nature of intelligence, but it is much more than a theory of intelligence. It has become a viable approach for exploring teaching styles, individualizing teaching and learning, developing curriculum, and improving teachers' literacy in assessment.

Since the development of the MI theory, many researchers have discussed its general application in the classroom [1, 7, 10], but few researchers have discussed these specifics as they apply to electronic learning (e-learning). Instructors, who upload/teach lessons online, can also apply MI theory. As students learn online, instructors can implement several intelligences to teach a concept. According to Gardner, everyone possesses nine distinct intelligences:

- *Verbal/Linguistic (VL)*: Ability to verbally or in writing explain, convince and express themselves
- *Visual/Spatial (VS*): Preference for thinking and creating pictures; are drawn to information that is presented in a visual form
- *Interpersonal (IEP)*: Preference for group based learning; are perceptive of moods and feelings of those around them
- *Intrapersonal(IRP)*: Have increased self-knowledge or preference for thinking about thinking
- Bodily Kinesthetic, BK: Preference for learning through sense of touch
- *Musical Rhythmic (MR)*: Ability to perform or write music and appreciate it.
- Logical/Mathematical (LM): Tendency to show interest in patterns, categories and relationships.
- *Naturalist (NA)*: Ability to discriminate among living things (plants, animals); display sensitivity to other features of the natural world (clouds, rock configurations).
- *Existentialist (EX)*: Sensitivity and capacity to tackle deep questions about human existence, such as the meaning of life, why do we die, and how did we get here.

Everyone has each of these intelligences, but in different combinations of strengths and weakness. Consequently, incorporating a variety of teaching strategies, addressing the respective intelligence will facilitate learning for those with the same respective aptitudes.

Of the nine intelligences, most classroom focus on and frequently assesses the verbal/linguistic and the logical/mathematical intelligences. The verbal/linguistic intelligence involves the effective use of oral and written skills. Teachers often address the logical/mathematical intelligence through mathematical problems-solving and teacher created scenarios requiring logical solutions. However, to successfully engage all learners, other intelligences must be addressed.

2. Purpose/Objectives

The purpose of this study was to establish baseline information regarding the distribution of learning styles among lower secondary smart school students. A secondary purpose was to establish for these individuals their preferred learning mode for selected learning topics according to the schools syllabus. The specific objectives of the study were:

1. To determine the learning style of the lower secondary students using the Multiple Intelligences Inventory and to examine the distribution of these styles among the respondents.
2. To determine the preferred learning mode of the respondents for selected topics.
3. To determine the effectiveness of selected learning activities and the impact of learning style on those learning activities.

3. Methods/Procedures

The logistic of achieving a true random sample of the entire population of lower secondary students in smart schools was infeasible within the time and financial constraints of this study. As an alternative to a random sample, a purposive sample was developed. In purposive sampling which is also known as judgement sampling, sample elements judged to be typical or representative are chosen from the population.

Permission was obtained from the Ministry of Education and then the respective Education Departments before distributing the survey instruments to students from the selected smart schools. A self-administered survey was distributed to 600 students from selected smart schools. Since there were direct follow-up with students in their respective classroom or common hall, all six hundred forms (100%) were returned and five hundred fifty (91.7%) were useable.

Two sets of survey instruments were designed. The first set of the survey determined the learning style of the respondents based upon Multiple Intelligences Inventory (MII). Respondents were given a time frame of 20 minutes to complete the first set. This inventory is adapted from Howard Gardner's work on multiple intelligences, and has been modified to cater all nine intelligences [6, 12]. The MI inventory consists of 90 open-ended statements with nine choices. Each choice corresponds to one of nine learning modes, which are combined to determine an individual's learning style.

The e-learning preferences questionnaire was divided into four sections and respondents were given

40 minutes to complete it. Section 1 collected demographic data and characteristics of the respondents. Section 2 was designed to determine online activity usage, section 3 of the survey measures respondents' contentment with e-learning. A 5-point likert-type scale was utilised. The final section of the survey determined individual's perspectives. Individual's perspectives were based on learning methods and technological aspects.

4. Findings on Learning Styles

Table 1 shows the learning styles of the respondents. The highest percentage of students preferred the visual/spatial learning style (16.18%), followed by VL, where the score is 15.45%. The score for IEP is 14.55%, followed by IRP, which is 12.73% of the total intelligences. The score for MR and LM intelligences are 12.18% and 9.45% respectively. These six intelligences were considered for this study as the numbers of students in these categories were more compared to other intelligences [8]. The least preferred mode was naturalist and existentialist (4.36% each). The findings also showed that there are students dominant in one or more intelligences. The data shows a predominance of male in VS and IEP intelligences and females in VL and IRP intelligences. However, the diversity of student population does vary in the real world. Therefore the results of this study may not be generalized to the entire population of students, the results can still provide valuable information to educational providers as they plan and deliver education program to students at all levels.

Table 1. Multiple intelligences of the respondents.

Multiple Intelligences	Male		Female		Total	
	n	%	n	%	n	%
Verbal-Linguistic (VL)	53	9.64	32	5.82	85	15.45
Visual-Spatial (VS)	64	11.64	25	4.55	89	16.18
Interpersonal (IEP)	58	10.55	22	4.00	80	14.55
Intrapersonal (IRP)	45	8.18	25	4.55	70	12.73
Musical-Rhythmic (MR)	58	10.55	9	1.64	67	12.18
Logical-Mathematical (LM)	35	6.36	17	3.09	52	9.45
Bodily Kinesthetic (BK)	26	4.73	13	2.36	39	7.39
Naturalist (NL)	17	3.09	7	1.27	24	4.36
Existentialist (EX)	20	3.64	4	0.73	24	4.36
Combination	13	2.36	7	1.27	20	3.64
Total	389	70.73	161	29.27	550	100.00

It is quite useful to show a class all of the scores from the inventory as it helps them to understand that everyone learns differently and there is no one best way of learning (Table 1. MI score). This also helps instructors to think about the MI class mix and how to create activities and assignments that will meet a variety of styles. It provides support for instructional designers who need to learn new ways to design instruction for electronic learning with multiple intelligences. Figure1 is shown in percentiles so that a score of 95 would indicate the 95th percentile and the learner would have a high need to have this style met. A score of 05 would indicate the fifth percentile – or a low need of the learning style for the learner.

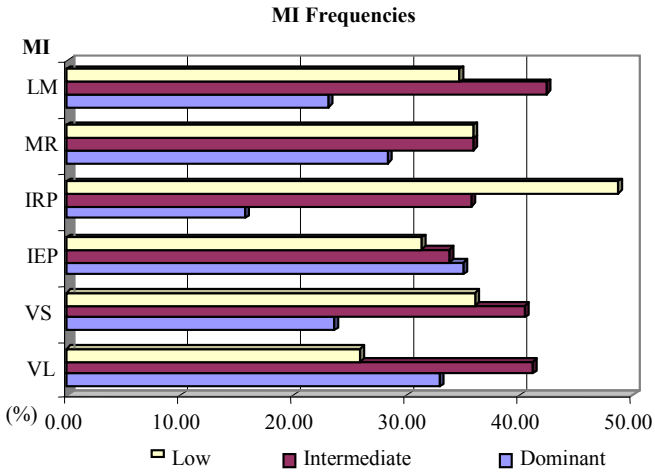

Figure 1. MI frequencies.

5. Surveying E-learning Preferences Based on Intelligences

Williams [16] explained that the magnitude of the correlation coefficient can be examined in terms of statistical significance. In other words, the closer the coefficient comes to -1 or +1, the stronger the relationship. Correlation coefficient values were calculated based on the results gathered from the two set of survey forms. The findings are further discussed in the following sections.

5.1. Online Activities Usage

Table 2 reports the mean, median and standard deviation of responses to the questions on the use of online activities. Scores range from 1 to 5, where a score of 5 indicates an activity that is undertaken daily. Majority of the learners had experience in personal computer and Internet use, but were never trained by E-learning methods. The following section describes frequency of use of computer and internet features to assist them in their learning process. Most students send/receive e-mail at least once a week. Students view class bulletin and school homepage in weekly basis to keep themselves up-to-date on the class activities or school announcements. Other homepage activities were optional but nevertheless attracted significant student usage. As shown in Table 2, in order of greatest online activities usage were review lecture slides online, participate in online group discussion, browse other sites related to the subject and add related links to 'favorites'. The least undertaken activity is adding attachments to e-mail.

Table 2. Online activities usage (N = 443).

Online Activities Usage	Mean	Median	Standard Deviation
Download and review notes online	2.384	2	0.898
Browse sites related to subjects	2.129	2	0.848
Add related links to favourites	2.016	2	0.803
Participate in online group discussion	2.323	2	0.868
Send/receive e-mail	2.560	3	1.113
Add attachments to e-mail	1.885	2	0.757
View class bulletins and school homepage	2.546	3	0.937

Scale: 1 = not at all, 2 = few times, 3 = once a week, 4 = a day after, 5 = every day.

5.2. Contentment

Students' responses to the questions on contentment with electronic learning were on average very positive (Table 3). Most students agreed or strongly agreed that web-based instruction contributed to their learning and understanding of the course material; although they slightly disagree that websites are easy to navigate and use. Most students said they were able to find a terminal and access web site and prefer to participate in synchronous and asynchronous learning. One area where there seemed to be strong agreement was that combination of lecture and computer session enabled them to do well in their course and that having lecture slides available online did not discourage their class attendance.

5.3. Individual's Perspectives

Individual's perspectives were gathered based on their learning methods and the technological aspects. Mean, median and standard deviation values were gathered for all six intelligences simply to highlight individual's perspectives based on the type of intelligences.

Table 4 reports that VL learners strongly agree that they read the entire web page before exploring the links in a web page. They also agree that they take down notes while attending lecture sessions and prefer to listen to pre-recorded spoken words. It is interesting to note that other than these items, they disagree with the rest of the items that favors the other categories of intelligences. VS and LM learners agree that they prefer to have flowchart to summarise read materials or learning contents. This is because VL learners tend to comprehend information more rapidly when it is presented to them through pictures, images, graphic organizers, mind-maps, concept maps and videos. On the other hand LM learners prefer to have flow chart to categorise topics into separate groups. MR learners strongly agree that they prefer to listen to background music while studying and they also agree that in order to memorise key facts better the create rhythm, rhyme, or mnemonics for selected topics.

Table 3. Contentment with electronic learning (N = 443).

Contentment	Mean	Median	Standard Deviation
Able to find terminal and access web site	3.907	4	0.691
Success based on combination of lecture and computer session	3.921	5	0.673
Online lecture slides easy to access and understand	3.993	4	0.636
Online lectures are readily available	4.000	4	0.613
Website easy to navigate and use	3.953	2	0.656
Online chat increases interest in course material	2.786	3	1.041
Utilising web site made difference in understanding concepts	3.984	4	0.684
Having lecture slide online discouraged me from attending class	2.199	2	0.759
Able to take part in synchronous and asynchronous learning	2.777	4	1.023
Direct response to questions by instructor via online communication tools	2.752	3	1.025

Scale: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree.

Table 4. Individual's perspective.

Individual's Perspectives (IP)		VL	VS	IEP	IRP	MR	LM
Learning Methods		n= 85	n= 89	n= 80	n= 70	n= 67	n= 52
IP1: Reads the entire web page before exploring the links	Corr.	0.778**	-0.550**	-0.444**	-0.502**	-0.507**	-0.482**
	Med	5	2	2	2	2	2
	SD	0.526	0.751	0.795	0.833	0.780	0.727
IP2: Prefer to have flowchart to summarize read materials	Corr.	-0.320**	0.749**	0.555**	0.287*	0.416**	0.545**
	Med	2	4	3	3	3	4
	SD	0.758	0.848	0.684	0.676	0.702	0.802
IP3: Prefer to insert bookmark to indicate last page read	Corr.	0.243*	-0.472**	-0.415**	0.939**	-0.409**	-0.445**
	Med	2	3	2	5	2	2
	SD	0.743	0.747	0.795	0.781	0.714	0.767
IP4: Prefer to listen to background	Corr.	0.239*	0.396**	-0.385**	0.817**	0.823**	0.468**

music while studying	Med	2	3	3	3	5	3
	SD	0.761	0.707	0.731	1.150	0.719	0.641
	Corr.	0.311**	-0.492**	-0.456**	0.339**	0.374**	0.764**
IP5: Prefer to organise separate items into larger groups	Med	2	3	3	3	2	4
	SD	0.768	0.772	0.826	0.755	0.832	0.760
	Corr.	0.320**	0.817**	0.517**	0.361**	0.294*	0.383**
IP6: Summarises read materials in point's format and graphical notation	Med	2	4	3	2	2	4
	SD	0.764	0.973	0.740	0.736	0.660	0.669
	Corr.	-0.237*	0.277**	0.767**	-0.423**	0.251*	-0.500**
IP7: Need other people's assistants to figure out things	Med	2	3	4	2	2	2
	SD	0.710	0.763	0.725	0.804	0.636	0.792
	Corr.	0.498**	0.263*	0.421**	0.839**	0.246*	-0.462**
IP8: Prefer to have diary to organise schedules , revisions and mark important dates	Med	2	3	3	5	2	2
	SD	0.966	0.754	0.808	0.767	0.709	0.804
	Corr.	-0.344**	0.391**	0.369**	0.382**	0.839**	-0.338**
IP9: Prefer to create mnemonics to establish pattern for memorization	Med	2	3	2	3	4	2
	SD	0.758	0.790	0.560	0.714	0.741	0.724
	Corr.	-0.321**	0.339*	-0.493**	0.489**	0.364**	0.846**
IP10: Prefer to have flow chart in geometrical shapes to summarise read materials	Med	2	3	2	3	3	4
	SD	0.758	0.817	0.811	0.705	0.682	0.757
	Corr.	0.725**	0.407**	0.467**	0.292**	0.387**	0.365**
IP11: Take down notes while attending lecture sessions	Med	4	3	2	3	3	3
	SD	0.839	0.852	0.815	0.676	0.660	0.572
IP12: Incorporate colour codes in learning materials to highlight key facts and indicate level of understanding	Corr.	0.296**	0.488**	0.470**	0.735**	0.472**	0.406**
	Med	2	3	2	4	3	2
	SD	0.732	0.733	0.856	1.004	0.708	0.564
IP13: Prefer to listen to pre-recorded spoken words rather than reading	Corr.	0.689**	-0.458**	0.421**	0.446**	0.746**	0.371**
	Med	4	3	2	3	4	3
	SD	0.749	0.757	0.808	0.804	0.815	0.534
IP14: Prefer to create rhythm, rhyme or rap to memorise key facts	Corr.	-0.401**	0.307**	-0.463**	-0.475**	0.853**	-0.520**
	Med	2	3	2	2	4	2
	SD	0.768	0.751	0.826	0.773	0.919	0.664
IP15: Prefer to summarise key facts, formulas or equations using mathematical notations	Corr.	-0.375**	-0.472**	-0.513**	-0.458**	-0.490**	0.877**
	Med	2	3	2	2	2	4
	SD	0.774	0.747	0.795	0.767	0.735	0.764
Technological Aspects							
IP16: Better interaction with peers and instructors through electronic learning	Corr.	0.222**	0.330**	0.701**	-0.472**	0.319**	0.492**
	Med	2	3	4	2	2	4
	SD	0.753	0.735	0.572	0.824	0.755	0.727
IP17: Prefer to have hyperlinks for texts	Corr.	0.838**	0.352**	-0.471**	-0.361**	-0.378**	0.577**
	Med	4	3	2	2	2	4
	SD	1.017	0.752	0.811	0.715	0.700	0.742
IP18: Prefer to view notes Power Point presentation slides format	Corr.	-0.315**	0.703**	0.545**	-0.459**	0.368**	0.698**
	Med	2	4	3	2	3	3
	SD	0.778	0.886	0.718	0.804	0.683	0.763
IP19: High interest in online group discussion	Corr.	-0.337**	0.683**	0.841**	-0.713**	0.590**	0.325*
	Med	2	4	5	1	4	3
	SD	0.768	0.866	0.495	0.802	0.743	0.595
IP20: Prefer to use calculation tools like Spreadsheet	Corr.	0.224*	-0.472**	0.489**	0.381**	0.341**	0.767**
	Med	2	3	2	3	3	5
	SD	0.734	0.747	0.827	0.753	0.637	0.505

IP21: Prefer to create short notes in word documents files (.doc format)	Corr.	0.725**	-0.484**	0.514**	0.394**	0.466**	-0.482**
	Med	4	3	2	3	3	2
	SD	0.839	0.732	0.827	0.773	0.698	0.727
IP22: Prefer to interact with animated and motion pictures	Corr.	0.222**	0.718**	0.540**	0.560**	0.519**	0.379**
	Med	2	5	4	3	3	3
	SD	0.758	0.503	0.467	0.801	0.641	0.638
IP23: Prefer to use collaborative tools or games	Corr.	-0.344**	0.290**	0.778**	-0.753**	0.503**	0.492**
	Med	2	3	4	2	3	3
	SD	0.758	0.772	0.557	0.824	0.680	0.668
IP24: Prefer to interact directly with instructor either via e-mail or face-to-face contact	Corr.	0.222**	0.286**	0.421**	0.826**	0.520**	0.664**
	Med	2	3	4	4	4	4
	SD	0.753	0.745	0.677	0.891	0.650	0.699

* Correlation is significant at the 0.005 level (2-tailed).
** Correlation is significant at the 0.001 level (2-tailed).

Verbal/linguistic students prefer to create short notes in word document. This may be due to the fact that many students were already familiar with computer especially Microsoft Office applications. Interpersonal learners strongly agree that they have high interest in online group discussion and agree that they prefer to use collaborative tools. Computer offer students who love to discuss their ideas and collaborate with others, a way to communicate with people in school and around the world. LM learners strongly agree that they prefer working with spreadsheet like Microsoft Excel to calculate values and store formulas for certain topics.

5.3.1. Correlation Between Multiple Intelligences and Individual Perspectives

On average, the correlation coefficient between items related to individual's perspectives on learning methods and technological aspect were determined by multiple intelligences. A very positive correlation for selected items specifies the preferences of users under that category of intelligence.

The question, "When examining a new web page, user reads the web page fully before exploring other links," was included to see if verbal/linguistic learners with their preferences for words and language also approach the web page similarly? The highest correlation coefficient, .78 for this item suggests that verbal/linguistic learners do approach the web in same manner as traditional learning method. Positive correlation for this item (IP1) shows that verbal/linguistic learners are able to read fast and understand most reading materials compared to other learners. The coefficient correlation value of 0.73 for item IP21 proves that student who possesses strong verbal/linguistic proclivities tend to create short notes as in word document files. The ease with which learners can edit their written work using word processors makes them more willing to do so, which in turn improves the quality of their content.

Item, IP22 showed higher correlation (0.72) for visual/spatial learners than for learners with other intelligences. This clearly indicates that visual-spatial learners prefer their online course related material to be incorporated with multimedia features like text, graphic, video and animation.

IEP learners who find appealing and interesting to use the internet are willing to share information with others through internet. This is because IEP learners prefer to do their learning cooperatively in groups or with a partner. Coefficient value of 0.77 indicates that IEP learners need other people's assistants to figure out things. On the other hand, IRP learners learn by thinking things through, and working alone. Therefore, these learners prefer to have diary/journal to organise schedules, revisions and mark important dates. A correlation coefficient of 0.84 for IEP learners and -0.71 for IRP learners suggest that IEP learners do approach the web differently than IRP learners. For instance, IEP learners actively participate in online group discussion like chat, forum, and whiteboard compared to IRP learners. This is because IEP learners' finds collaborative learning and communities of practice for students and teachers enhance learning and understanding of all subjects. Overall, students choose to interact directly with instructor either via e-mail or face-to-face contact.

Students with LM intelligence prefer to organise separate items into larger groups, work with calculation tools, summarise key facts using mathematical notation or flow chart in geometrical shapes. These items show very positive correlation values, more than 0.7. On the other hand, a very positive correlation values for MR learners are shown for items such as listening to pre-recorded spoken words and background music. They also prefer to create mnemonics, rhythm, rhyme or rap to memorise key facts.

Students from all six types of intelligences depict positive correlation value for item IP24. This shows that students interact with peers and instructors via e-mail and they are familiar with e-mail features like

sending/receiving e-mails, download attachment and add attachment to e-mail messages.

6. Implications and Future Research

The results of this study confirmed the diversity of approaches to learning that characterize students. There are two lessons to take from the present study. First, instructors need to expand web-based teaching technologies so that they are not merely online extension of traditional learning tools (lectures, outlines, test/quizzes). The e-learning application should include communication tools (e-mail, forum, and chat), organization tools (bulletin, calendar, online diary) and various presentation methods of course content (flow diagram, pre-recorded spoken words, animated pictures, games, etc.). By expanding web based teaching technologies, instructors will not be only focusing on students with verbal/linguistic and logical/mathematical intelligences but also other intelligences. For some suggestions of list of online activities that corresponds to the intelligences refer Kema *et al.*[9].

Second, students should be given chance to work with activities based on their dominant intelligence as well as second and third level of intelligences. Learning activities are most likely to be effective when the preferred learning mode is combined with a variety of other activities associated with learning modes. For example, students with IEP intelligence should be given opportunity to work with learning materials in collaborative mode and use communication tools like chat or forum for group discussion to support their approach of better understanding a study topic.

Future research is needed to replicate this study using larger samples derived from higher learning institutions and corporate sectors. Also, questions directed more specifically at particular aspects of electronic learning techniques need to be explored. With better information about which aspects of e-learning instruction appeal to which learners, we would be better able to enhance the appeal of our instructional approach for a wide range of learners.

7. Conclusion

A review of technologies and students learning style based on multiple intelligences shows that no one technology is suited for all students and all curricula. Technologies should be chosen to support a diverse student population and their unique learning styles. It is inappropriate for instructors to assume that all students can learn in the same way and can be force-fitted to one method of delivery. The chosen technologies should also support the type of content to be shared with diverse intelligence of students and the expected learning outcomes. Technology has the power to support students and teachers in gathering, organizing, manipulating and presenting information. When both are encouraged to use their innate intelligences creatively, e-learning environment can enhance what the individuals are able to produce and their level of satisfaction.

By correlating students' multiple intelligences scores and their preferences for internet based instruction, we were able to identify learning technologies that appeal to particular learning types. Although the results of this study may not be generalized to the entire population of lower secondary students, the results can still provide valuable information to educational providers as they plan and deliver education program to students at all level. With the increasing use of the Internet for educational purposes by students of diverse and dissimilar backgrounds, the solutions of these research issues will reinforce the power of information and educational technology in the future.

References

[1] Armstrong T., *Multiple Intelligences in the Classroom*, Association for Supervision and Curriculum Development, Alexandria, VA, 1994.

[2] Bransford J., Brophy S., and William S., "When Computer Technologies Meet the Learning Science: Issues and Opportunities," *Journal of Applied Development Psychology*, vol. 21, no.1, pp. 59-84, 2000.

[3] Carver C. A., Howard R. A., and Lane W. D., "Enhancing Student Learning Through Hypermedia Courseware and Incorporation of Student Learning Styles," *IEEE Transactions on Education*, vol. 42, no. 1, pp. 33-38, 1999.

[4] Elsayed-Elkhouly S. M., "Recent Developments of Human-Computer Interfaces Problems and Recommendations," *Logistics Information Management*, vol. 8, no. 6, pp. 43-46, 1995.

[5] Gardner H., *Frames of the Mind: The Theory of Multiple Intelligences*, Basic Books, New York, 1983.

[6] Ivanco J., "MI Inventory: What are My Learning Strengths?," available at: http://snow.utoronto.ca /courses/mitest.html, April 2001.

[7] Kagan S. and Kagan M., *Multiple Intelligences: The Complete Book*, Kagan Cooperative Learning, San Clemente, Calif, 1998.

[8] Kemalatha K. "Survey Results: Internal Report," University of Malaya, Kuala Lumpur, 2002.

[9] Kemalatha K., Lee S. P., and Palaniappan A. K., "A Model of E-learning Application Accommodating Multiple Intelligences," *in Proceedings of Hawaii International Conference on Education*, Hawaii, USA, 2004.

[10] Lazear D., *Seven Ways of Knowing: Teaching for Multiple Intelligences*, Palatine, Skylight, 1991.

[11] Leuthold, J.H., "Is Computer-Based Learning Right for Everyone?," *in Proceedings of the 32nd Hawaii International Conference on System Sciences*, Hawaii, 1999.
[12] McKenzie W., "Multiple Intelligences Survey," *Intelligences Survey*, available at: http:// surfaquarium.com/MIinvent.htm, March 2001.
[13] Montgomery S. M., "Addressing Diverse Learning Styles Through the Use of Multimedia," available at: http://fre.www.ecn. purdue.edu, April 2001.
[14] Perniu D., Ursutiu D., Cotfas P., and Voinicu O. X., "The Use of Computers to Address Diverse Learning Styles in Chemical Instruction," *in Proceedings of the Interactive Computer Aided Learning Symposium (ICL'99)*, IN Villach, Austria, October, 1999.
[15] Pimentel J. R., "Design of Net-learning Systems Based on Experiential Learning," *Journal of Asynchronous Learning Networks*, vol. 3, no. 2, pp. 64-90, 1999.
[16] Williams F., *Reasoning with Statistics*, 4th Edition, Fort Worth, 1992.
[17] Zywno M. S. and Waalen J. K., "The Effect of Individual Learning Styles on Student Outcomes in Technology-Enabled Education," *Global Journal of Engineering Education*, Australia, vol. 6, no. 1, pp. 35-44, 2002.

Kemalatha Krishnasamy received her BSc with (Hons) and her MSc in software engineering. Both degrees were obtained from University of Malaya in 1999 and 2000, respectively. Currently, she is working towards the PhD degree in computer science in the area of electronic learning at the Faculty of Computer Science and Information Technology, University of Malaya, Kuala Lumpur. Her research interests include the areas of e-learning, multiple intelligences, computer supported collaborative work, and human computer interaction.

Sai Peck Lee received a PhD degree in computer science from PARIS I. She is now an associate professor at the University of Malaya. Her research interests include object-oriented application framework, object-oriented modeling of e-commerce application, object-based information systems development support environment, software reusability, formal specification language, software requirement engineering, software design engineering, and tool integration.

Ananda Kumar Palaniappan is an educational psychologist presently lecturing in the University of Malaya. He specializes in organizational creativity, creative problem solving and creativity. He has conducted workshops and presented papers on creativity and innovation, organizational creativity, organizational behavior and creative problem solving for numerous groups in Malaysia, Singapore and the United States of America. He has been consulted on projects by many agencies including the Malaysian Ministry of Education and Dewan Bahasa dan Pustaka. He is presently involved in several research projects on creativity, creative personality characteristics, creative management and organizational behavior. He is an active member of MIPM, Malaysian Invention and Design Society, Institute Fizik Malaysia, and Malaysian Council of Computers in Education.