Evaluation on the Usability of Physics Module in a Secondary School in Malaysia: Students' Retrospective

Norlidah Alias [1], Saedah Siraj [2], Dorothy DeWitt [3], Mohammad Attaran [4], Abu Bakar Nordin [5]

[1] Department of Curriculum and Instructional Technology
University of Malaya,
50603 Kuala Lumpur, Malaysia
drnorlidah@um.edu.my

[2] Department of Curriculum and Instructional Technology
University of Malaya,
50603 Kuala Lumpur, Malaysia
saedah@um.edu.my

[3] Department of Curriculum and Instructional Technology
University of Malaya,
50603 Kuala Lumpur, Malaysia
dorothy@um.edu.my

[4] Department of Curriculum and Instructional Technology
University of Malaya,
50603 Kuala Lumpur, Malaysia
attaran@um.edu.my

[5] Department of Curriculum and Instructional Technology
University of Malaya,
50603 Kuala Lumpur, Malaysia
a_bakarnordin@um.edu.my

ABSTRACT

The main objective of this study is to implement and evaluate the Physics module based on technology and learning style using students' retrospective evaluation. Physics has always been thought of as the most difficult subject as it involves abstract concepts. Research has shown that technology has the potential to increase understanding of abstract concepts. Previous research shows that matching learning style strategy with certain technology will be able to increase students learning experience. ICT which has potential to display learning experience in variety of format is seen as one way to fulfill diversity of learning styles. This study is based on the Felder Silverman Model (1988) which comprises four dimensions (visual/verbal, active/reflective, sequential/global, sensing/intuitive). The design and development of the Physics modules comprising technology tools, teaching technique, activities and advance exercise comes from the modified Delphi technique. The researchers employed 14 Physics students to test the Physics module which comprises two lessons on `gas law'. Following this, the students were interviewed to seek insight in order to evaluate the Physics module according to teachers' retrospective evaluation of the modules. This paper will discuss the strengths and weaknesses of the Physics module from the students' retrospective evaluation. This paper will further discuss the implication of the research to practice. The modules help students to learn abstract Physics concepts according to technology and students' learning style. Based on these findings, the researchers suggest that these Physics module which is based on technology and learning styles can be an effective teaching and learning instructional package.

Keywords: *Students' retrospective evaluation, Physics module, technology, learning style, curriculum*

INTRODUCTION

Past research shows that most of the students are still having difficulties in understanding concepts in Physics (Mazur, 1997; McDermott, 1993; Ramsdell, 2004). The same scenario is in Malaysia as the students have the weakness in mastering Physics and they assume that Physics is something that is abstract (Abdullah Nor, 1998; Shahanom Nordin, 1994). According to Daniel (2004), based on the analysis that has been done on the questionnaires in `Cikgu Sains' website from January 1998 until August 1999, the topic, `Kinetics' and `Dynamics' are the most problematic topic for the Physics students. In the matter that involves Physics Pedagogy, the result from the study carried out by Kamisah Othman, Lilia Halim and Subahan Mohd Meerah (2006) in determining the needs analysis on 1690 Science teachers, shows that the teachers need information on how technology should be integrated in their teaching skills. According to Roblyer and Doering (2010), six emerging technology trends that have direct impact on teaching and learning activities are wireless communication, merging of technologies, development of mobile tools, existence of high speed communication, visual immersion systems and intelligent application.

Past research shows that matching the Physics concept, technology and learning styles can increase the students' knowledge on mastering the concepts (Hein, 1997; Ross & Lukow, 2004; Tsoi, Goh & Chia, 2005; Wong, 2001). Until now little research has been done on the development and evaluation of Physics module based on

learning style for Form 4 Physics curriculum. For this reason, in this study the researchers would like to observe the use of Physics module based on technology and learning style by secondary school Physics students and further evaluate the module implementation and its usability from students' retrospective evaluation. This evaluation which uses students' retrospective evaluation is able to give input regarding the strengths and weaknesses of the Physics module based on technology and learning style which can be further improved. It is hoped that the evaluation of this module is important and useful to give balance towards the teaching which is based on the differences of each individual in the classroom.

GOALS

The purpose of this study is to evaluate the implementation of Physics module based on technology and learning style using students' retrospective evaluation. At the same time, this study evaluates the strengths and deficiencies of Physics module implementation. Based on the above purpose, this study would provide answers to the following question:

1. What is the usability evaluation of Physics module based on technology and learning style according to students' retrospective evaluation?

RESEARCH APPROACH AND METHODOLOGY

Theoretical Framework

The theoretical framework for this research comes from a combination of a theory and three models which are Social Constructivist Theory, Felder and Silverman Model (1988) and Taba Model (1962). The discussion begins with Social Constructivist Theory for the process of teaching and learning, followed by Felder and Silverman Model (1988) for learning style theory and next Taba Model (1962) for the design of the curriculum.

Social Constructivism

Social Constructivism was developed by a psychologist, Lev Vygotsky (Slavin, 2006; Woolfolk, 2007). Vygotsky's theory has resemblance with Piaget's assumption on how students learn; however the main contribution of Vygotsky's theory is the emphasis on social learning context (Slavin, 2007). According to Piaget, teacher plays limited role in the leaning process. On the other hand, according to Vygotsky, teacher plays an important role in learning. Vygotsky believes that learning occurs when an individual works in the z*one of proximal development (ZPD).* In this case, social constructivism states that assignment in the ZPD zone is not being able to be solved by the students yet, but with the help and assistance from adults and their friends, they would be able to understand the concept and idea (Slavin, 2006; Woolfolk, 2007).

Besides that, *scaffolding* is also an important idea in social constructivism by Vygotsky. In this case, guidance from a competent individual such as teacher or friend is given at the beginning of the lesson. Later through the learning the guidance is being reduced until the students are given full responsibility when they are ready (Slavin, 2006; Woolfolk, 2007).

This study has employed social constructivism theory in implementing the pedagogical module based on technology and learning style for secondary school Physics curriculum in Malaysia. The teaching and learning in the module is set in the form of assignment and the students are asked to explore and generate idea on Physics concepts such as Charles' Law and Boyle's Law. The teachers will guide the students if they have problems and the students may refer to other friends during the teaching and learning process as what Vygotsky has stated as Z*one of Proximal Development* as *`actual developmental level as determined by independent problem solving' and the higher level of 'potential development as determined through problem solving under adult guidance or in collaboration with more capable peers'* (p. 86).

In this research, ZPD and *scaffolding* are employed. Firstly, example of *scaffolding* is when the teacher guides the students if they face any problem accessing the wireless internet until at the end the students are able to access it on their own. Secondly, another example of ZPD is the students can always refer to the teacher and their friends during the teaching and learning process. Thirdly, the digital resource support such as Webquest gives *scaffolding* to learners through providing students with a few suitable links, where eventually the students get to choose their own link.

Felder and Silverman Model (1988)

Felder and Silverman (1988) have created a learning model that brings focus to the learning styles aspects among Engineering students. After three years, a psychometric instrument which is Felder-Soloman's Index of Learning Styles is created. This model has classified the students into eight categories based on four dimensions: visual/verbal, active/reflective, sequential/global, sensing/intuitive.

The characteristics of each learning style of the Felder and Silverman Model (1988) is explained in Table 1.

Table 1. The Characteristics of Learning Style of the Felder and Silverman Model (1988)

Learning Style	The Characteristics
Sensing	Sensing learner prefers learning facts, solve problem in order with related examples, more careful in doing practical work, like memorizing and does not like lesson that has no relationship with life outside the class.
Intuitive	Intuitive learner prefers to learn new things, works faster with not in order situation, does not like memorising facts and prefers mathematics formulae and abstract things. This type of learner does not like teachers to repeat lesson that he/she has learned before and prefers innovation.
Active	Active learner would better understand and remember what he/she will learn through doing, discussing and explaining to others, prefers to work in group and does not like lecture.
Reflective	Reflective learner would prefer to work alone and try to think quietly in order to solve problem and prefers lecture.
Visual	Visual learner can remember what they learn better through picture, figure, flow charts and demonstration. They would prefer teacher to teach with teaching aids and lots of graphics.
Verbal	Verbal learner prefers listening to teachers or group discussion and prefers reading aloud and repeating reading a few times.
Sequential	Sequential learner can understand better when instruction is being delivered from easy to complex. He/she finds it difficult to get the true picture of something and cannot relate to other subject or discipline. In solving problems, he/she would prefer easily understood way.
Global	Global learner can understand things in holistic manner and quite slow and unsystematic in problem solving unless he/she get the complete picture on certain matter. He/she would prefer to relate knowledge or past experience in order to understand certain things and able to relate to other subject or other discipline.

Taba Model (1962)

Taba (1962) uses grass root approach in developing the curriculum (Ornstein & Hunkin, 1999). Taba believed that curriculum should be designed by teachers and not be set from the top down. The reason is that teachers are the ones who start the smallest lesson unit for the students in the class. Based on this belief Taba introduces inductive approach to develop the curriculum which starts from specific to a more general design.

Taba Model (1962) outlines 5 steps in developing curriculum:

Step 1: Produce the smallest lesson unit using 8 steps:

- Diagnose learners' need
- Set the objective
- Select the content
- Arrange the content
- Select the learning experience
- Arrange the learning activities

- Set what to evaluate and how to evaluate

Step 2: Try the unit that has been produced

Step 3: Re-checking the lesson and do adjustment.

Step 4: Re-checking the scope and the flow of the programme

Step 5: Use and distribute the product of the lesson.

Usability Evaluation Using Students' Retrospective Evaluation

This research uses the usability evaluation framework by Chai and Chen (2004). Chai and Chen (2004) usability evaluation framework provide clear guidelines to classify types of usability evaluation based on three parties involved in the usability evaluation. The three parties involve are:

a. the system under evaluation which can be in the form product that has been released or prototype or design document

b. user

c. evaluator that are going to evaluate.

The three parties, depending on the focus of the evaluation, may change their roles in certain situations and hence produce the choice of evaluation method. Table 2 shows the roles of the three parties in determining the choice of evaluation method.

Table 2. Usability evaluation method framework

The Role of the System	Users' Role	Evaluator's Role	Type of Evaluation Method
Presence	Users perform certain tasks using the system	Evaluator evaluates the interaction between user and the system	Usability Test
(The System exists during the evaluation)	No real user involved	Evaluator evaluates interaction between evaluator and the system	Usability Observation
Absence	Users have finished certain tasks using the system	Evaluator evaluates user reaction towards interaction with the system	User Retrospective
(The System is not present during the evaluation)	No real user involved	Evaluator evaluates her/his reaction towards interaction with the system	Evaluator Retrospective

Source. Adaptation from C. S. Chai and D. Chen (2004). A review on usability evaluation methods for instructional multimedia: an analytical framework. Retrieved from *Instructional Journal of Multimedia Vol. 31*(3), 2004, p. 231. (http://www.eric.ed.gov/contentdelivery/servlet/ERICServlet?acc.no=ED501628).

Based on the table, usability evaluation is divided into four methods. Usability test and usability observation are used when the system is present. On the other hand, user retrospective and evaluator retrospective are used when the system is not present. This means that user or evaluator had an experience with the system and the system was not present during the evaluation. Hence, in this research, the researchers chose user retrospective as the most suitable method to evaluate the Physics module based on learning style. The justifications are that firstly, students in this research had had an experience using the Physics module in their lessons. Secondly, the module was not present when the evaluation took place. Lastly, the researchers interviewed the students to know their reaction to the Physics module that they had used.

METHODOLOGY

This study is to evaluate the usability of Physics module implementation using students' retrospective evaluation in a secondary school in Klang, Malaysia. Laptops and broadband had been utilized in this study. Moreover, video clip and Webquest had been used as the supporting digital resources in this study. These elements are selected from the outcome of the design and development of the module based on the modified Delphi technique. This paper does not discuss the design and development part of the module as the aim of this research is to evaluate the usability of Physics module implementation only. The elements of the Physics module based on learning style are shown in Table 3 until Table 6.

Table 3. Active learning style elements for Lesson 1 and Lesson 2: Gas Law

Technology Tools	Electronic Digital Resource	Teaching Technique	Activities	Exercises
Laptop	Webquest	Group Project	Post answers in the Blog	Do group work

Table 4. Reflective learning style elements for Lesson 1and Lesson 2: Gas Law

Technology Tools	Electronic Digital Resource	Teaching Technique	Activities	Exercises
laptop	Video clip	Individual drill	Wiki	Produce mind map

Table 5. Visual learning style elements for Lesson 1 and Lesson 2 : Gas Law

Technology Tools	Electronic Digital Resource	Teaching Technique	Activities	Exercises
laptop	Webquest	Experiment/demonstration in pairs	Wiki	Produce Power point

Table 6. Verbal learning style elements for Lesson 1 and Lesson 2: Gas Law

Technology Tools	Electronic Digital Resource	Teaching Technique	Activities	Exercises
Laptop	Video clip	lecture	tutorial	Present assignment

The gas law involved in this research are Boyle's Law and Charles Law. Two teachers and 14 form 4 Physics students from four learning style were involved in the implementation of this research. The two teachers were then interviewed in the retrospective evaluation. The schedule of the research is shown in Table 7.

Table 7. Implementation Schedule

Week	Teaching & Learning	Duration	Learning Activity
Week 1	Distribution of Index of Learning Style (ILS) Instrument	2 hours	Introduction and distribution of ILS instrument to two science classes.
Week 1	Distribution of agreement letter from parents to allow their children's involvement in the research.	1 hour	Explanation of the implementation schedule.
Week 2	Students' Orientation	2 hours	Introduction to email, Blog, Power Point to the participants in the pilot test and in the research.

Week 2	Teachers' Orientation	1 hour	Introduction to Physics module and distribution of printed Physics module to two Physics teachers. Lesson 1: Mr Sobri (not the real name) Lesson 2: Mrs Tee (not the real name)
Week 3	Pilot Test 1	2 hours	Mr Sobri teaches using Physics module Lesson 1 with 14 participants.
	Pilot Test 2	2 hours	Mrs Tee teaches using Physics module Lesson 2 with 14 participants.
Week 4	Implementation of Lesson 1	2 hours	Mr Sobri teaches using Physics module Lesson 1 with 14 participants.
	Implementation of Lesson 2	2 hours	Mrs Tee teaches using Physics module Lesson 2 with 14 participants.
Week 4	Interview	3 hours	2 teachers

An example of the teachers' module is shown in Figure 1 and Figure 2.

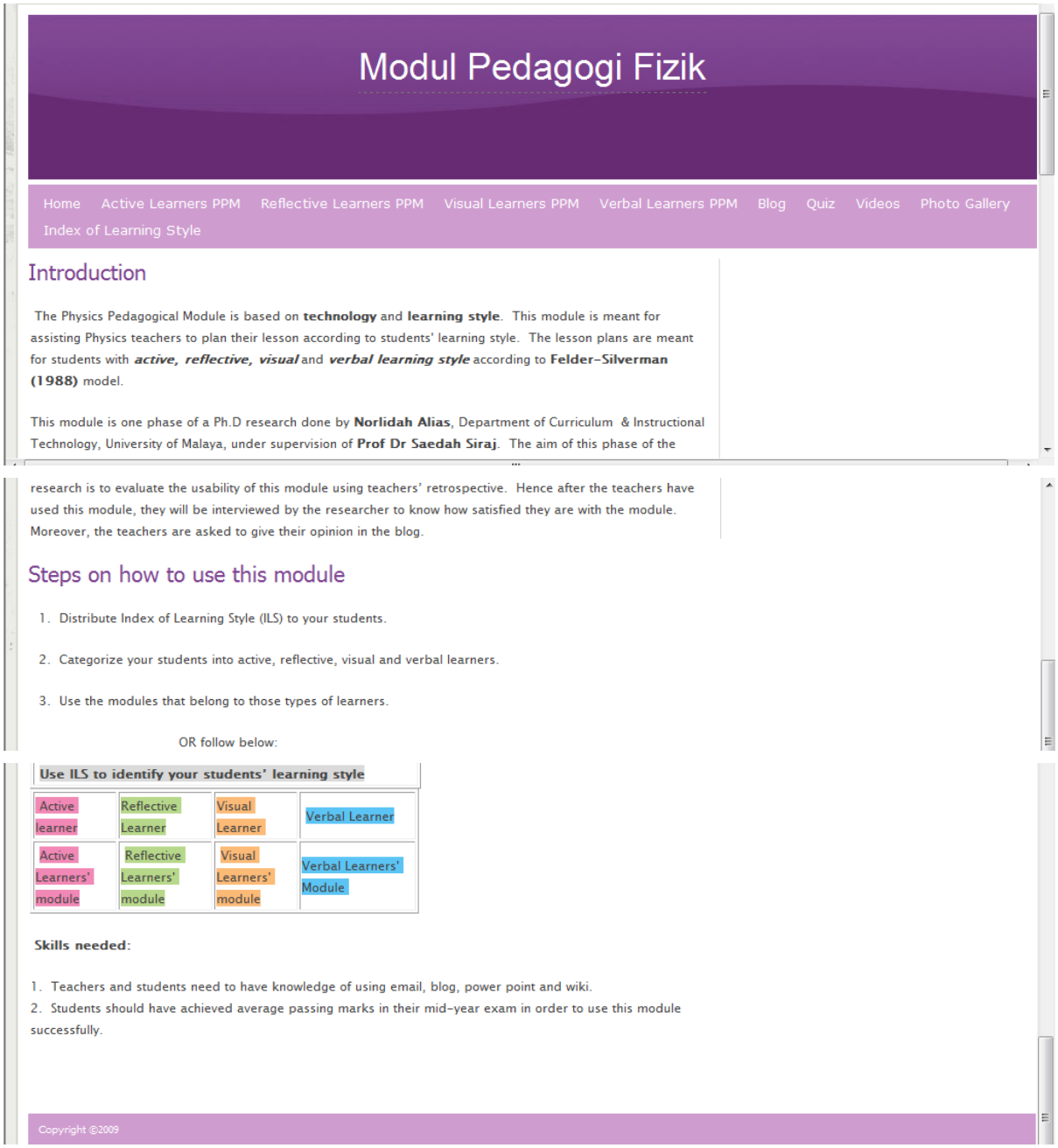

Figure 1. Physics Pedagogical Module http://modulpedagogifizik.webs.com

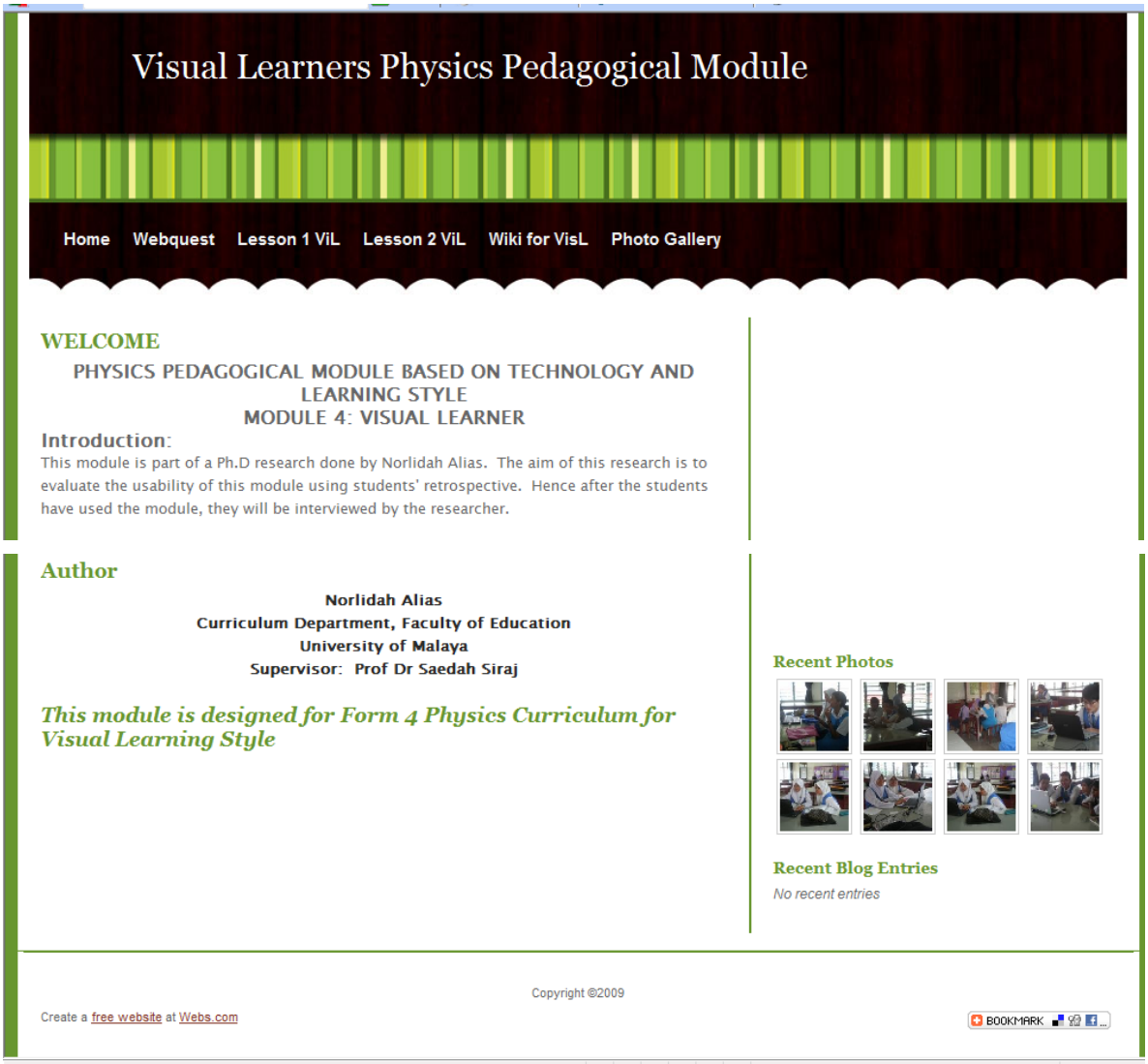

Figure 2. Visual learners module http://visuallearnersppm.webs.com

DATA ANALYSIS PROCEDURE

The interview data with fourteen students has been analyzed thematically.

FINDINGS

The results of interview provide the students' retrospective of the usability evaluation of the Physics module based on learning style:

1. Provide space and chance to students to learn according to their learning style.	Learning style … no teacher allows me to learn alone. Haha … I think … learning this way … I like it … definitely suites me.(R1: 150) My learning process becomes easier because I can understand Easily with what the video clip tries to explain (VB2:50)
2. Understanding Physics concept.	I had to think. Not only doing copy, paste. (V1:133) Unbelievable! I can still remember until now. (R1:47) Effective … haa … that's it. I can still remember till now. (R1:186)
3. Encouraging effective two way communication.	So if we learn using this way, some sort of communicating, through communication, we give opinion before doing any work. (A1:33)

4. Students like Physics more.	Aaa … because Physics normally does not interest me. I know … I know the basic of Physics but I do not know how to apply them. Hence, when I use power point, webquest, I am really clear with the whole topic. (V1: 58) Learning Physics become much more fun this way. All the videos and exercises helps. I really hope that someday I might learning at school with technology like this (Aiman's blog, Oct 5 2009)
5.Improves students' ICT skill.	My new experience is that I explore more on power point and more towards knowledge. If I use the internet, knowledge, seek for knowledge … and try to get kowledge from the internet and apply it. (V1: 84)
6. The Physics Module has the potential to be implemented in the future.	I … want and hope that the researchers will strive to make it successful. (V1:65) Suitable. I think this module is useful because if not, there are a few students that do not care for Physics as they think it is a difficult subject, they would neglect the subject and nobody to motivate them.(V1: 145) I think you (the researchers) should produce more on this type of mLearning Module based on learning style and not only for your experiment, you may also publish the blog for public to use. (V1:161)
7. The module is easy to follow and interesting.	From aspect … if the text book I can get facts only … if using this module I can get the real picture. (V2:53) This module … you can easily understand certain thing. It is not like … If all words, all like difficult to understand … boring. This module is really attracting my attention and easy.(V2:60)

DISCUSSION AND IMPLICATION

In the context of this research, the findings from teachers' retrospective evaluation shows that the Physics module based on technology and learning style can help students understand the Physics concepts. This result supports the literature that technology and learning style have potential to ease the understanding of abstract concepts (Hein, 1997; Offerjost, 1987; Ross & Lukow, 2004; She, 2007; Tsoi, Goh, & Chia, 2005; Wong, 2001). Next, the findings also show that the Physics module has encouraged an effective two-way communication which agrees with the literature that technology encourages two-way communication between teacher and students (Ahmad Sobri Shuib, 2009; Chin Hai Leng, 2009; Saedah Siraj & Norlidah Alias, 2006).

In addition, in the context of this research, the finding shows that the Physics module has increased teachers' and students' ICT skills. This finding supports the viewpoint of Ahmad Sobri Shuib (2009) that usage of laptop and wireless technology can increase students ICT skills. Next, on the part of the students, the modules have increased their interest in Physics. This part of the finding further supports research findings by She (2007) and Offerjost (1987). Besides that, the finding also agrees with the literature that students who are being taught in the learning situation that takes into account learning style difference, can easily receive and are more interested to learn new and difficult information (Hein, 1994). Finally, the finding of this study revealed that the Physics module is practical to follow and interesting as also agreed upon by Saedah Siraj and Norlidah Alias (2006) as well as Livingston and Conde (2003).

As a whole, the present study has practical implications. The modules help students to learn abstract Physics concepts according to technology and students learning style. On the part of students, learning abstract concepts becomes more manageable. In addition, the experts consensus in the modified Delphi Technique is found another added value as it fulfills four out of six emergent technologies as suggested by Roblyer and Doering (2010).

CONCLUSION

In conclusion, this Physics module which is based on learning style has many strengths as identified through teachers' retrospective evaluation. Firstly, the Physics module gives space and chance to students to learn according to their learning style. Secondly, the module can help students understand abstract Physics concept. Thirdly, the module also allows effective two way communication between students and teachers. Next, it is evidence that students like Physics more. It should also be noted that the module helps to upgrade students' ICT skill. Next, the Physics module has the potential to be implemented in the future. It has been proven that the Physics module is practical and interesting. This study has revealed that Physics module based on learning style has its positive impacts

on students' interest towards learning Physics.

The researchers strongly propose that the curriculum should include the module which integrates technology and learning style. Policy planners such as the Curriculum Development Division, Ministry of Education Malaysia should give serious consideration on this matter. In terms of material, the module is another alternative to the present textbooks. The content and tasks can be updated and refined to suit the diverse context of Physics learners and time. These findings can also aided the interaction-designers of Technology Education Division, Ministry of Education Malaysia in planning and developing tools and teaching-learning approach that could fulfill current and future teachers-students' requirements based on technology and learning style. In addition, the experts consensus in the modified Delphi Technique is found to be another added value as it fulfills four of six emergent technologies as suggested by Roblyer and Doering (2010). Based on these findings, the researchers suggest that the Physics module which is based on technology and learning styles can be effective teaching and learning instructional package.

REFERENCES

Abdullah Nor. (1998). Kajian mengenai beberapa faktor yang mempengaruhi kecenderungan terhadap Fizik bagi pelajar-pelajar tingkatan empat. Latihan Ilmiah. Universiti Kebangsaan Malaysia, Bangi, Selangor.

Ahmad Sobri Shuib. (2009). Reka bentuk kurikulum M-Pembelajaran sekolah menengah. Disertasi Ijazah Doktor Falsafah yang tidak diterbitkan, Universiti Malaya, Kuala Lumpur.

Chai, C. S., & Chen, D. (2004). A review on usability evaluation methods for instructional multimedia: an analytical framework. Retrieved from Instructional Journal of Multimedia, 31(3), p. 231. ERIC Fulltext: http://www.eric.ed.gov/contentdelivery/servlet/ERICServlet?acc.no=ED501628

Chin Hai Leng (2009). Pembangunan dan Penilaian Laman Portal Pembelajaran Tatabahasa Bahasa Melayu Tingkatan Dua. Disertasi Ijazah Doktor Falsafah yang tidak diterbitkan, Universiti Malaya, Kuala Lumpur.

Daniel, E. G. S. (2004). Penggunaan laman web pakar: Masa depannya dalam pendidikan Sains. Dalam Noraini Idris, Daniel E. G. S., & Rohaida Mohd Saat, Teknologi dalam pendidikan Sains dan Matematik (hlm. 93-120). Kuala Lumpur: Penerbit Universiti Malaya.

Felder, R. M., & Silverman, L. K. (1988). Learning Style and Teaching Styles in Engineering Education. Engr. Education, 78(7), 674-681.

Hein, T. L. (1997). Digital video, learning styles and students understanding of kinematics graph. Doctor of Philosophy, Kansas State University. Retrieved from ProQuest Digital Dissertations database. (Publication No. 9736737).

Kamisah Othman, Lilia Halim, & Subahan Mohd Meerah. (2006, July). What Malaysian Science teachers need to improve their science instruction: A comparison across gender, school location and area of specialization. Eurasia Journal of Mathematics, Science and Technology (Edn.). 2(2). Retrieved from http://www.ejmste.com/022006/d4.pdf

Livingstone, K., & Condie, R. Evaluation of the SCHOLAR Programme. Final report for the Scottish Executive Education Department. Edinburgh: Scottish Executive. Retrieved from http://www.flatprojects.org.uk/evaluations/evaluationreports/scholarreport.asp

Mazur, E. (1997). Peer Instruction: a user's manual. Englewood Cliffs, NJ: Prentice Hall.

McDermott, L. C. (1993). Millikan Lecture 1990: How we teach and how students learn- A mismatch? American Journal Physics 61, 295-298.

Offerjost, J. L. (1987). The use of microcomputer to teach color concepts: effectiveness and relationship between attitudes and learning styles. Clothing and Textiles Research Journal 5(2), 8-14. Retrieved from SAGE Online Journals.

Ornstein, A. C., & Hunkin, F. P. (2004). Foundations, principles and issues (4th ed.). New York, NY: Allyn.

Ramsdell, M. W. (2004). The design, development, and assessment of advanced modeling based project in introductory Physics. Doctor of Philosophy, Clarkson University. Retrieved from ProQuest Digital Dissertation database. (Pub. No. 3139893).

Roblyer, M. D., & Doering, A. H. (2010). Integrating educational technology into teaching (5th ed.). Boston, MA: Allyn.

Ross, C. M., & Lukow, J. E. (2004). Are learning styles a good predictor for integrating instructional technology into a curriculum?. Journal of Scholarship of teaching and learning 4(1), Retrieved from http://www.iupui.edu/~josotl/2004vol4no1/RossLukow.pdf

Saedah Siraj, & Norlidah Alias (2006). An evaluation of MLearning. The International Journal of Learning, 12(4), 187-197. Retrieved from http://www.Learning-Journal.com

Shahanom Nordin. (1994). Penghasilan dan penilaian Keberkesanan Modul Pengajaran Kendiri Fizik di kalangan pelajar berbeza kebolehan dan jantina pada peringkat Tingkatan 4. Tesis Doktor Falsafah. Universiti Teknologi Malaysia, Skudai, Johor.

She, H. C. (2005). Promoting student's learning of air pressure concept: The interrelationship of teaching approaches and student learning characteristics. The Journal of Experimental Education 74(1), pp. 29-51. Retrieved from ERIC database. (Pub. No. EJ726374)

Slavin, R. E. (2006). Educational psychology: Theory and practice (8th ed.). Boston, MA: Pearson.

Smaldino, S. E., Russell, J. D., Heinich, R., & Molendo, J. D. (2005). Instructional Technology and Media for Learning, (8th ed.). Upper Saddle River, NJ: Pearson.

Tsoi, M. F., Goh, N. K., & Chia, L. S. (2005). Multimedia learning design pedagogy: A hybrid learning model. US-China Education Review, 2(9), 59-62. Retrieved from http://www.80/2b/c1/6e.pdf

Wong Mei Ling. (2001). Design and development of the Bio-webclean for Form Four students of different learning styles. Unpublished Masters dissertation. University of Malaya, Kuala Lumpur.

Woolfolk, A. (2007). Educational Psychology (10th ed.). Boston, MA: Pearson.