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]

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 learning 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 zone 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 Zone 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)

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>The Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensing</td>
<td>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.</td>
</tr>
<tr>
<td>Intuitive</td>
<td>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.</td>
</tr>
<tr>
<td>Active</td>
<td>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.</td>
</tr>
<tr>
<td>Reflective</td>
<td>Reflective learner would prefer to work alone and try to think quietly in order to solve problem and prefers lecture.</td>
</tr>
<tr>
<td>Visual</td>
<td>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.</td>
</tr>
<tr>
<td>Verbal</td>
<td>Verbal learner prefers listening to teachers or group discussion and prefers reading aloud and repeating reading a few times.</td>
</tr>
<tr>
<td>Sequential</td>
<td>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.</td>
</tr>
<tr>
<td>Global</td>
<td>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.</td>
</tr>
</tbody>
</table>

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**

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


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

<table>
<thead>
<tr>
<th>Technology Tools</th>
<th>Electronic Digital Resource</th>
<th>Teaching Technique</th>
<th>Activities</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptop</td>
<td>Webquest</td>
<td>Group Project</td>
<td>Post answers in the Blog</td>
<td>Do group work</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Technology Tools</th>
<th>Electronic Digital Resource</th>
<th>Teaching Technique</th>
<th>Activities</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>laptop</td>
<td>Video clip</td>
<td>Individual drill</td>
<td>Wiki</td>
<td>Produce mind map</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Technology Tools</th>
<th>Electronic Digital Resource</th>
<th>Teaching Technique</th>
<th>Activities</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>laptop</td>
<td>Webquest</td>
<td>Experiment/demonstration in pairs</td>
<td>Wiki</td>
<td>Produce Power point</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Technology Tools</th>
<th>Electronic Digital Resource</th>
<th>Teaching Technique</th>
<th>Activities</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptop</td>
<td>Video clip</td>
<td>lecture</td>
<td>tutorial</td>
<td>Present assignment</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Week</th>
<th>Teaching &amp; Learning</th>
<th>Duration</th>
<th>Learning Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Distribution of Index of Learning Style (ILS) Instrument</td>
<td>2 hours</td>
<td>Introduction and distribution of ILS instrument to two science classes.</td>
</tr>
<tr>
<td>Week 1</td>
<td>Distribution of agreement letter from parents to allow their children’s involvement in the research.</td>
<td>1 hour</td>
<td>Explanation of the implementation schedule.</td>
</tr>
<tr>
<td>Week 2</td>
<td>Students’ Orientation</td>
<td>2 hours</td>
<td>Introduction to email, Blog, Power Point to the participants in the pilot test and in the research.</td>
</tr>
<tr>
<td>Week</td>
<td>Activity</td>
<td>Duration</td>
<td>Details</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Week 2</td>
<td>Teachers' Orientation</td>
<td>1 hour</td>
<td>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)</td>
</tr>
<tr>
<td>Week 3</td>
<td>Pilot Test 1</td>
<td>2 hours</td>
<td>Mr Sobri teaches using Physics module Lesson 1 with 14 participants.</td>
</tr>
<tr>
<td></td>
<td>Pilot Test 2</td>
<td>2 hours</td>
<td>Mrs Tee teaches using Physics module Lesson 2 with 14 participants.</td>
</tr>
<tr>
<td>Week 4</td>
<td>Implementation of Lesson 1</td>
<td>2 hours</td>
<td>Mr Sobri teaches using Physics module Lesson 1 with 14 participants.</td>
</tr>
<tr>
<td></td>
<td>Implementation of Lesson 2</td>
<td>2 hours</td>
<td>Mrs Tee teaches using Physics module Lesson 2 with 14 participants.</td>
</tr>
<tr>
<td>Week 4</td>
<td>Interview</td>
<td>3 hours</td>
<td>2 teachers</td>
</tr>
</tbody>
</table>

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

![Physics Pedagogical Module](http://modulpedagogifizik.webs.com)

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

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


