The Development and Evaluation of Thermodynamics Multimedia Software for Post Secondary Engineering Students

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Abstract: Thermodynamic is an integral part of engineering system. The aim of this study is to develop and evaluate effectiveness and usability of multimedia interactive learning software for a topic of Steam Power Cycle based on Mechanical Department of Malaysian Polytechnic Curriculum for Module J 2006 Thermodynamic I. The aim of the software is to assist student’s understanding of lesson contents. This software is developed using LabView 6i as an authoring tools while Hannafin & Peck model is used as a working frame in the development of software. Image, texts, graphic and animations are combined in order to motivate and to produce an interesting interface design. The method used in evaluating the effectiveness is a quasi-experiment on eighty students (80) as respondent which are the second semester students of Certificate in Mechanical Engineering. Mechanical Department, Ungku Omar Polytechnic, Ipoh, Perak. The research instruments are a software compiled in form of CD-ROM, software questionnaire with 5 point Likert Scale. The pre and post test is administered to both experimental and control groups. Descriptive statistic (mean, %, sd) is used to analyse feedback on usability and inferential statistic (t-test) is used to analyse the effecitiveness of the software. The descriptive data analysis showed that the multimedia software is well accepted by the mechanical students since all aspects evaluated have the mean value at level between 3.01 – 5.00 which is at the highest level. The differential mean of post test in control group (m = 62.2) and treatment group (m = 80.35) are greater which is 29.2%. This indicates increased of the score which showed the application of multimedia software increases the performance of the students. To test the hypothesis, the α-level of 0.05 is used for a significant level. The study reveals that the students using software scored higher in the post-test as compared to the control group. The t-test reveals that there are no significant different in pre and post test score for the control group. Meanwhile there are a significant different of pre-test and post-test mean between experimental and control group as well as between pre-test and post-test mean for the experimental group. It appeared that multimedia software developed by the researcher could aid and help students in their understanding of the topics discussed. It can also considered as an effective alternative choice of learning material Steam Power Cycle topic at Polytechnic level.

Key-Words: Multimedia Learning; Engineering Education Malaysia

1 Introduction

The Twenty First Century is known as an information communication technology era that brings a lot of challenges and opportunities today and a head of us. To be in the positive side, we have to take this rapid ICT development as an opportunity at the same time be prepared of its challenges. ICT plays very important and significant roles in today’s education. One of the development is on e-learning which Malaysia has also aggressively ventured into[1]. e-learning is defined as a learning environment that can promotes interaction between tutor and students using multimedia information communication technology. Multimedia technology is capable of enhancing students understanding and interaction using all modes of senses. Teachers as well should take this potential opportunity to apply it to their teaching with innovative approach that has more control over learning of diverse group of students. More importantly, using e-learning students are also able to control their own learning hence experience a more interesting and effective learning.
The advancement of technology should be manipulated and integrated with the learning theories available in producing a more effective teaching and learning materials. In line with the characteristics of multimedia, constructivism theory is found to be suitable to be used in developing multimedia teaching and learning [2]. Traditionally multimedia design was very behaviorist, however with ICT capabilities, constructivism theory can be applied in the design of the multimedia teaching and learning materials especially to produce more creative and critical thinking students. Thus multimedia not only functional as information provider but it also can stimulate thinking and new learning through problem solving experience furthermore will motivate students learning especially in difficult subject such as engineering subjects.

Engineering subject is always considered as a difficult subject because of its abstract concepts involved. However engineering education is a paramount important type of education in providing the nation with innovative, creative and critical thinking human capitals who can make sure the sustainability of the economy. To achieve this, a good program of engineering education at all level of higher learning institutions should be in placed. One of the criteria is to have innovative teaching and learning where ICT is integrated into the processes.

2 Problem Formulation

Polytechnics system is one of the tertiary education systems which provide pre-university engineering education in Malaysia. Its aim is to produce semi professional human capitals in technical disciplines in helping Malaysia to realize its vision of being fully industrialized country by the year 2020. Therefore, a study to improve teaching and learning practices in the areas is in deed important and timely.

Core engineering subjects in mechanical engineering such as Thermodynamic is one of the subject where students having difficulties in. Through a need analysis survey conducted, it revealed that among the difficulties faced is the problem of understanding the concepts and furthermore hinder the students from applying the concept in higher level learning such as problem solving and designing. Beside this, the teaching strategies used by the lecturers are also considered in a traditional mode of lecturing which is more static and fail to convey the picture of real world problem.

Hence, integration of theory and practical should be dealt with more seriously.

Therefore, the main objective of the study is to develop and evaluate the feasibility of a multimedia software for Thermodynamic course focus on the specific topic of Steam Power Cycle for second year students in Polytechnics using LabVIEW programming language.

3 Methodology

The methodology is divided into two parts which are design and development methodology and methodology for evaluation of userbility and effectiveness of the software.

3.1 Design and Development

Both Hannafin & Peck [5] and ASSURE models were used as a Conceptual Framework (Figure 1 and 2) in designing and developing of the software. The development processes went through three phases: i) need analysis ii) Design iii) Development and implementation. Evaluation and modification was made at every phase. ASSURE model Heinich (1999) is a procedural model that is used as a guide in planning the use of media in teaching and learning.
for students’ needs. ASSURE which stands for 

\( A = \text{Analyze learners;} \quad S = \text{State objective;} \quad S = \text{Select methods, media and material;} \quad U = \text{Utilize media and materials;} \quad R = \text{Require learner’s participation;} \quad E = \text{Evaluation and revise,} \)

helped researcher in designing and strategized the content for multimedia software.

The language used was LabVIEW (Laboratory Virtual Instrument Engineering Workbench). LabVIEW is an efficient graphic language programming which can generate, analyze and present data [6] [7]. The software developed in the form of CDROM which students can always install it for their personal used. LabVIEW has user interface consist of front panel (Figure 4) and Block Diagram (Figure 5).

3.2 Methodology for evaluation of usability and effectiveness of the software.

A questionnaire was used to evaluate the usability of the software. Students for the experimental group were asked to give their feedback on the extent the software has elements of student’s prior experience, students centred activities, systematic structure and discovery learning.

Pre and post test were used to determine the effectiveness of the software in improving students understanding of the topic. The pre-test were administered to both control and experimental group before the lesson begin. The post-test were administered to experimental group only after they went through the lesson for 8 weeks.

4 Problem Solution

4.1 Software Components

The software has 5 main components namely

i) Menu skin – attractive icons were used with some encouragement messages to motivate student’s learning (Figure 6)

ii) Location matrix – enable user to move from one mode to another using guided icons (Figure 7)

iii) Exploration buttons – User can explore the software with flexible movement using button click with some motivation messages (Figure 8)

iv) Facilitator’s interface – Instructor/facilitator can always modify the content of the software while in used.

v) Student’s interface – student can actively involve in the activity by having their own input and see the effect of it for example in the calculation activity (Figure 9).
4.2 Usability Assessment

Table 1 shows mean scores and standard deviations for each element assessed to see the students feedback on elements of student’s prior experience, students centred activities, systematic structure and discovery learning. The result revealed that all elements were rated high by the students except the systematic structure where the students found that the content of the courseware was ill-structured and did not motivate them to learn the topic. They also found that they can not read the topics repeatedly.

<table>
<thead>
<tr>
<th>Elements Assessed</th>
<th>Mean</th>
<th>S.D</th>
<th>Level</th>
</tr>
</thead>
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<tr>
<td>student’s prior experience</td>
<td>3.63</td>
<td>0.99</td>
<td>H</td>
</tr>
<tr>
<td>Student-centred activities</td>
<td>3.35</td>
<td>0.824</td>
<td>H</td>
</tr>
<tr>
<td>Structured courseware</td>
<td>3.11</td>
<td>0.78</td>
<td>M</td>
</tr>
<tr>
<td>discovery learning</td>
<td>3.24</td>
<td>0.8</td>
<td>H</td>
</tr>
</tbody>
</table>

4.2 Courseware Effectiveness

T-test was used to analysed the differences between control and experimental group on their pre and post-tests scores. The result showed that there was no significant different on the pre-test result of both experiment and control groups. Meanwhile the experimental group appeared to be high in their post test as compare to the control group. The t-test revealed that the different was statistically significant (Table 2) which indicates that students who experience learning with the courseware have better understanding of the topic.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>sd</th>
<th>t</th>
<th>df</th>
<th>p</th>
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<tbody>
<tr>
<td>Pre-test</td>
<td>40</td>
<td>65.70</td>
<td>6.91</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Post Test</td>
<td>40</td>
<td>80.35</td>
<td>6.61</td>
<td>-13.60</td>
<td>39</td>
<td>0.000</td>
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<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>sd</th>
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<tr>
<td>Post-test</td>
<td>40</td>
<td>62.20</td>
<td>7.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>contro group</td>
<td>40</td>
<td>80.35</td>
<td>6.61</td>
<td>15.08</td>
<td>39</td>
<td>0.000</td>
</tr>
</tbody>
</table>

5 Conclusion

It can be concluded that lecturers need to make their teaching interesting by employing variety of methods. This could be done using courseware which allow for self-directed and flexible learning. Instructors can benefit from available programming language such as LabVIEW which is easy to learn and does not required complicated technical skills. The courseware developed can also be used to cater for diversified learners.
References:


