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The Development and Evaluation of an E-Module for Pneumatics Technology

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Abstract

Pneumatics technology is an integral part of industrial automation. The aim of this study was to produce an electronic module (e-module) prototype with a multimedia approach in an attempt to assist students' understanding of lesson contents. The results of the study revealed that the e-module produced conforms to the requirements by students in terms of contents, teaching strategies, the teaching presentation and software application. The e-module is also found to be suitable to serve as an alternative learning material that assists the learning of pneumatics in the subject of industrial automation.

INTRODUCTION

Electronic learning, also known as e-learning, is not new in our current Malaysian educational scenario. Norafida Ithnin & Othman Ibrahim (2000) defined e-learning as the environment which enhances the interaction between the learner and the tutor through the use of the computer and software and courseware that utilise information technology and communication. With the advancement in computer technology, the modern computer can do more than simply processing plain texts and executing simple spreadsheets. Multimedia, which refer to the presentations of information using various approaches by combining two or more media forms, have proved to be effective and successful in teaching and learning, especially in higher learning institutions (Zaidatun Tasir & Yap Sao Wen, 2000).

Engineering has become one of the most important technical fields in our country. With Vision 2020 in mind, the engineering education field had evolved as the main player in catering to the needs for technical expertise in our nation. Engineering education becomes crucial in producing graduates who are competent in skills. In the context of mechanical engineering, engineering education means a good integration between the theoretical and practical aspects. Mechanical engineering graduates need to have a sound understanding of technical knowledge. Good learning material that assists students to understand content becomes important in this form of education that blends together theoritical and practical elements.

In the field of mechanical engineering, pneumatics technology is the integral part of industrial automation. Industrial automation is the field related to automation and the sequences of industrial machinery to enhance productivity. Nearly eighty percent of industries worldwide utilise pneumatics in their manufacturing systems (Schmudlach et al., 2000). Due to its importance, industrial automation is one of the most important components in mechanical engineering education. However, the pneumatics system is hardly understood by most students. Based on informal interviews with Kolej Universiti Tun Hussien Onn (KUiTTHO) students who have already taken the course on pneumatics tchnology, it was found that they had difficulties in understanding the working principles of a given peumatics system presented in diagrammatic form. They were only able to visualise the operations of a given system when they conducted the experiments involving actual pneumatic components. In addition, they could hardly understand the symbols used in the pneumatic diagrams presented during the course of their studies. In such conditions, students were unable to construct an actual pneumatics system after being given the pneumatic schematic diagram

since they did not possess a strong basic understanding of the pneumatics theory. Since the pneumatics system is widely used in the industrial automation system, a good understanding of pneumatic principles is crucial to enable students to interpret and solve complex industrial automation problems.

Based on past findings, it was found that students from Germany also encounter similar a problem with the topic of pneumatics. For instance, students have been facing difficulties in building a practical and working pneumatic system as they do not understand the working principles of the given pneumatics circuit diagram (Brauer, 1998). However, the study done by Hornecker & Robben (1999) found that the use of graphic presentations could help in solving this problem. Graphic presentations such as animation could assist students in understanding the operation of pneumatics circuits faster as students would have a better idea of the working principles of the system. Since animation is one of the multimedia elements and with the advancement in computer technology, it is possible to present the pneumatics course module in a multimedia format with animation as the main agenda for teaching the subject to students. The study by Hornecker & Robben (1999) and Brauer (1998) serves as the starting point for this research as the writer would like to see how far a multimedia electronic module (e-module) in pneumatics Ttchnology can serve as a feasible solution for students with this particular problem.

This study is aimed at producing an electronic module (e-module) prototype with a multimedia approach in an attempt to assist students to understand pneumatics and to evaluate its suitability as alternative learning material for the students. The objectives of this study are as follows:

(a) To develop an electronic module (e-module) with multimedia elements to assist students to understand pneumatics technology
(b) To evaluate the suitability of the e-module as alternative learning material for the students.

This study only focused on learning problems among the students in the field of pneumatics. The students were limited to those pursuing the Diploma of Mechanical Engineering at KUiTTHO. Contents presented in this module only concentrate on basic pneumatics without involving any aspects of a hybrid pneumatics system such as electro-pneumatics.

METHODOLOGY

This research is a product-based quantitative research which includes the development of a product (e-module) as well as the collection and analysis of quantitative data by means of research instrumentation. Quantitative research is based on strategy implementation where variables are manipulated in an experimental situation (Siti Zarida Syed Nordin, 2002). A questionnaire was used as the instrument for data collection in this study. The respondents consisted of Diploma students in the field of mechanical engineering at KUiTTHO who were attending the industrial automation course. Based on the survey, it was found that there were only 32 students registered for the subject during the course of this study. Therefore, the samples taken were the 32 students (Krejeie & Morgan, 1970).

The research instrument for data collection in this study was a questionnaire which was distributed together with the e-module for evaluation by the respondents. The questionnaire served as an instrument to obtain feedback from these respondents regarding various aspects of the e-module. The questionnaire was divided into seven sections. The first section (Section A) aimed at obtaining demographic profiles of the respondents while the remaining sections (Section B to G) were related to the design of the e-module. Items presented to the respondents were related to contents, the presentation of modules, the usage of multimedia elements, user friendliness, the screen design, navigational and help aspects as well as opinions from the respondents regarding the suitability of

implementation. The Likert scale on a scale of 5 was used as options for Section B to G as shown in Table 1.

Table 1: The Likert Scale Format

Score Value	1	2	3	4	5
Indicator	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

The design of the questionnaire in this study was adapted from the questionnaires designed by Siti Zarida Syed Nordin (2002), Zaidatun Tasir & Yap Sao Wen (2000), Noor Azlina Hashim (2002) and Woo (2003). Besides the scale items, respondents were also asked to give their overall opinion regarding the e-module through open-ended questions at the final section of the questionnaire.

THE E-MODULE DEVELOPMENT

The developed e-module was aimed to assist students in understanding the contents on pneumatics. The targeted users were the Diploma students taking the industrial automation course. The module could also serve as introductory learning material for students prior to taking the Iidustrial automation course and for those who are interested.

The e-module was in the form of a compact disc (CD). The users were given the option of either running the module directly from the CD or installing the module into their personal computer. The module could also be removed from the computer should the users wish to obtain some free space in their hard drive. The screen shot for the opening menu is shown in Figure 1. The e-module consisted of four main sections: the introduction, the basic components of pneumatic systems, the introduction to pneumatic circuits and the principles of pneumatic circuits. Besides these, there were other options such as the navigation map and a "Help" option in case any assistance was required in using the module. The contents of the pneumatics technology e-module were presented in the Malay language to suite the syllabus requirements of the respondents. The screenshot for the main menu of the e-module is as shown in Figure 2.

Figure 1: The Opening Screen of the E-Module.

Figure 2: The Main Menu Screen of the E-Module.

The development of this e-module was based on the ADDIE development model. ADDIE stands for Analysis, Design, Development, Implementation and Evaluation that represent the important phases in developing a good e-module. The ADDIE model was used in the development of the e-module in this study since it could be widely adapted by other courseware designers (Jamalludin Harun et al., 2001). The instructional design of the e-module followed the principles of instructional design written and stated by experts such as Graham (1999), Baharuddin Aris et al. (2002) and Jamalludin Harun et al. (2001). The instructional design was important in ensuring a good design for the interface, screen presentation, interactivity and multimedia in the e-module.

The development of the e-module prototype was based on software packages readily available on the Internet. The authoring software used was *Autoplay Media Studio 4.0 Demo* due to its simplicity and user friendliness. Other software packages such as *Xara Webstyle 3.1* and *Cool MP3 Splitter* were used for graphics and sound manipulation. For animation, the writer used *Swish 2.0* to create flash animations for pneumatic circuits animation. All the software mentioned is readily available online. Apart from all these, the software that is provided with the CD Rewritable (CD-RW) Drive called *Nero Burning Rom* was used for CD burning.

Upon the completion of the e-module development, the e-module prototype was verified by content experts in the field of pneumatics. Comments and suggestions by the experts were taken into account for the final amendments to the e-module. After the e-module was completed, a pilot study was conducted where the e-module, together with the questionnaire, was distributed to ten randomly-picked students to be tried out and their feedback to be obtained within a week. Then, the questionnaires data were entered into a statistical software package called *SPSS 10.0* for reliability analysis based on the Alpha-Cronbach score. If the Alpha-Cronbach score was greater than 0.7, the design of the questionnaire would be considered as good (Gardy, 2002). Otherwise, the questionnaire would have to be updated accordingly until the score exceeded 0.7. After the pilot study was successfully carried out, the actual study followed with the distribution of the verified e-module and questionnaire set. The data collection process took place after the respondents had completed the questionnaire. The data analysis was done using *SPSS 10.0* statistical packages.

RESULTS

The e-module prototype was sent to content experts prior to the actual study. Content experts consisted of those who were teaching the industrial automation course and experts in related fields. The verification of the e-module was successfully done with all the experts agreeing that the e-module prototype was well designed and well suited to the learning of students at the Diploma level. Besides the verification of the e-module, results from the pilot study also showed that the questionnaire was reliable since the Alpha-Cronbach score produced was over 0.7 for each section of the questionnaire. The actual study was conducted after the verification of the e-module and the reliability test for the questionnaire. The analysis of data showed that there were 12 female respondents (37.5%) out of l the 32 respondents. All the respondents who were pursuing a Diploma in the mechanical engineering course at KUiTTHO did not possess any knowledge of pneumatics prior to taking the industrial automation course.

For Sections B to G, the respondents were given numerical options from 1 to 5 on their perception towards the various aspects of the e-module presented to them. They had to circle a number from 1 to 5 to indicate their preference, with 1 being the "strongly disagree" and 5 being the "strongly agree" options. In the analysis, the number of respondents in each group who had circled 1 and 2 were grouped under the category "disagree" while those who had circled 4 and 5 were grouped under the category "agree". Those who circled 3 were categorised as "neutral".

The results regarding contents in Section B are presented in Table 2. The findings indicated that the majority of the respondents agreed that the contents were comprehensive (87.5%), easy to understand (90.7%), related to the topics they had learned (90.6%) and were systematic (96.9%). In terms of examples given in the module, 90.7% of the respondents thought that the language used for explanations was simple and easy to understand, with nearly 85% of them agreeing that the contents were free from spelling errors. The presentation of the module (Section C) included the presentation of module contents as well as the navigational aspects of the interactive module. As shown in Table 3, all the respondents agreed with the statement that the learning objectives for the module were clearly written. Overall, 93.8% of the respondents perceived that the introduction of the contents was good and systematically arranged. In terms of navigation, all of them agreed that they had control over the presentation flow of the e-module, with the ability to move forward, backward or out of the contents. It was discovered that over 90% of the respondents found the module interesting while 81.3% of them felt that it helped them to be able to reflect on what they had learnt.

Table 2: Results for Items in Section B

Item Label	Item	Percentages of Respondents (%)		
		Disagree	Neutral	Agree
B1	Contents are comprehensive	0.0	12.5	87.5
B2	Contents are easily understood	3.1	6.3	90.7
B3	Contents are related to syllabus topics	0.0	9.4	90.6
B4	Systematic presentation of contents	0.0	3.1	96.9
B5	Easily understood examples given	0.0	3.1	96.9
B6	Examples given are realistic	3.1	12.5	84.4
B7	Good language usage in content presentation	3.1	6.3	90.7
B8	Contents are free of spelling errors	0.0	15.6	84.4

Table 3: Results for Items in Section C

Item Label	Item	Percentages of Respondents (%)		
		Disagree	Neutral	Agree
C1	Learning objectives are clearly written.	0.0	0.0	100.0
C2	Good introduction of topics	0.0	6.3	93.8
C3	Able to move forward and backward of contents	0.0	0.0	100.0
C4	Able to move out of the contents	0.0	0.0	100.0
C5	Systematic presentation	0.0	12.5	87.5
C6	Content presentation suits student's learning style	0.0	9.4	90.7
C7	The module is interesting	3.1	6.3	90.7
C8	The module helps you to do reflection	3.1	15.6	81.3

The majority of the respondents also agreed on the suitability of the multimedia usage in this module. The items related to multimedia presentation and interactivity were presented in Section D of the module, as shown in Table 4. Of all the respondents, 93.8% agreed that the e-module had a good interface design. They also agreed on the suitability of the text (90.7%), graphics (87.5%) and colour usage (84.4%) in the e-module. 93.7% of respondents agreed that the animation helped them to understand the contents. However, only three-quarters of them (75%) thought that the audio presentation used was suitable in the e-module. Overall, 90.7% of them agreed that some degree of interactivity existed between the e-module and the learner.

Table 4: Results for Items in Section D

Item Label	Item	Percentages of Respondents (%)		
		Disagree	Neutral	Agree
D1	Interface is well-designed.	0.0	6.3	93.8
D2	Good arrangement of media	0.0	9.4	90.7
D3	Text usage is suitable in the contents	3.1	6.3	90.7
D4	Graphics usage is suitable in the contents	3.1	9.4	87.5
D5	Colour usage is suitable in the contents	6.3	9.4	84.4
D6	Audio usage is suitable in the contents	6.3	18.8	75.0
D7	Animation helps in understanding the contents presented	0.0	6.3	93.7
D8	Interactivity exist between the e-module and the learner	0.0	9.4	90.7

The study revealed that the respondents also had positive feedback regarding the user friendliness (Section E) of the e-module as shown in Table 5. 93.8% of the respondents thought that the e-module was user friendly. They felt that the navigational help in the module was easily understand (93.8%) and was able to assist them to access the contents they intended (90.7%). The respondents also agreed that the usage manual could be easily referred to (87.5%) and was helpful for e-module usage (96.9%). In addition, 87.5% of the respondents also thought that the e-module was stable and would not easily "crash" or "hang".

Table 5: Results for Items in Section E

Item Label	Item	Percentages of Respondents (%)		
		Disagree	Neutral	Agree
E1	This module is user friendly	0.0	6.3	93.8
E2	Navigational help in the module is easily understood	0.0	3.1	93.8
E3	Navigational help facilitates access to the contents.	3.1	9.4	90.7
E4	The user manual is helpful	0.0	3.1	96.9
E5	The user manual can be easily referred to	0.0	12.5	87.5
E6	The navigation buttons used are easily identified according to their functions	0.0	6.3	93.7
E7	The navigation buttons are consistently used in terms of functions	0.0	6.3	93.7
E8	The e-module is stable and does not easily "crash" or "hang"	0.0	12.5	87.5

Overall, 85.4% of the respondents thought that the e-module had assisted them in learning. Over 90% of them (95%) thought that the module was suitable to assist students in learning pneumatics. The results for module applicability is shown in Table 6 below. Most respondents felt that the module could be distributed to students who learn pneumatics. In the last section on general assessment, the respondents were asked their opinions about the e-module and whether they would recommend it in pneumatic education. The feedback showed that most of them were satisfied with it but felt that improvements had to be made on the presentation of information in the text, graphics and audio used. The results also revealed that most of the respondents would recommend the usage of this e-module as alternative learning material although the e-module still needed improvements in various aspects.

Table 6: Results for Items in Section F

Item Label	Item	Percentages of Respondents (%)		
		Disagree	Neutral	Agree
F1	This module helps you in your learning of pneumatics	0.0	15.6	85.4
F2	This module is able to assist students in learning pneumatics	3.1	3.1	94.8
F3	This module can be used by lecturers as a teaching aid during lectures.	3.1	9.4	87.5
F4	This module can be distributed to students who are taking the pneumatics course as a learning aid	0.0	6.3	93.8

DISCUSSION AND CONCLUSIONS

The results from the study have been positive. Overall, the perception of respondents towards the e-module produced was encouraging. The findings revealed that items related to contents produced good responses. Respondents also had good impressions towards the presentation style, interactivity as well as the blending of multimedia elements into the module, with the exception of the audio elements. In terms of user friendliness, respondents were happy with all the assistance features of the e-module such as the navigational help and user manual embedded inside the e-module.

The results from this study revealed that the e-module produced conformed to the requirements of students in terms of contents, teaching strategies, teaching presentation and software application.

Promising results were produced by the study where positive feedback was received regarding the e-module. Based on the feedback, it was believed that the design, contents and presentation of the e-module still had some room for improvement. The improvements included adding contents related to pneumatics such as electro-pneumatics, including more work examples and enhancing interactivity by having interactive quizzes or tutorial sections. Further enhancements in interactivity, including the design of the pneumatics circuit using templates, was also feasible. Furthermore, the presentation of contents in the English language was also suggested to cope with the translation period of engineering contents from the Malay to the English language.

The e-module was found to be suitable to serve as alternative learning material that would assist the learning of pneumatics in the subject of industrial automation. The respondents felt that the e-module would be suitable in assisting students to learn the subject. However, improvements still had to be made to the module to make it better. This included the presentation of information in the text and the graphics and audio materials used. Respondents also commented that the animation features could be improved for better presentation. Overall, the results of the study showed that the study was successful in achieving its objectives. The e-module was successfully produced with all the features intended and the evaluation of the e-module was carried out successfully.

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