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Design and Development of Semiconductor Courseware For Undergraduate Students

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Abstract: The aim of this study was to design and develop a computer courseware which serves as an e-book as a challenge towards e-learning application. The courseware entitled 'Fundamental of Semiconductor Devices' is intended to assist undergraduate-level student' learning by bringing a sense of reality to the concepts. The fast prototype design model is used to develop the courseware with the aid of the Macromedia Flash MX2004, Swift 3D, Adobe Photoshop development tools. The main purpose of this courseware is to overcome the student's misconception on several topics of semiconductor devices and to develop an e-book of Semiconductor Devices. Graphical animated presentations were designed to provide a solution to overcome misconception. Two pre-test and post-test were carried out, to monitor the student's performance before and after using the software. The sigma value at 95% confident intervals, reduce from 0.4 for the pre-test to 0.05 for the post-tests. The students' perception towards the courseware prototype is respectively positive and acceptable the mean score value exceeded 4.16 (SD = 0.76) for each items given. The results indicate that the prototype courseware offers students a real life understanding of the concept. The present study also showed that the students performed better and accept the multimedia software in their learning session, with sigma value <0.05 for post-test 1 and post-test 2. Using Likert scale (total mean of score = 4.16 and SD = 0.76) with Alpha Croanbach of 0.89 (>0.7) concluded that the courseware is acceptable.

Key words: Misconception, perception, multimedia, semiconductor, devices, e-book

INTRODUCTION

With the rapid growth of e-learning, a technological revolution is currently taking place in higher education learning institution. Generally, e-learning is a learner-centered educational system which enables learners to learn whenever, wherever and whatever the learners want to learn according to their learning objectives (Rosenberg, 2001). Educational technologies provide numerous advantages in the areas of contextual, active, self-paced and individualized learning, and automation so that learners can choose appropriate learning content and paths themselves and understand their learning progress and achievement (Tsai, 2009).

Courseware, also known as instruction or educational software, is widely used in higher education as an essential part of the courses. Courseware or multimedia integration into instruction has become a very effective tool for learning (Alessi and Trollip, 2001).

In general, courseware can play the role of a tutor, a tool, or a tutee. Interactive multimedia courseware can be divided into several categories, based on the emphasis of the courseware. In this discussion, the development of courseware focuses on drill and practice, tutorial, tests, web-based learning, hypermedia, and simulations. Although courseware development and its application in classroom lectures is becoming more greatly emphasized, its design and use have been more focused on courses related to sciences and technology (Azemi, 2008; Tsai, 2009). That is because instructors in these fields have more competent skills and knowledge of multimedia software and programming so that they are less hesitant to convert their lecture notes into an interactive package that can be available to students.

Group of researchers have developed ways to teach microelectronic processing which related to the semiconductor devices using interactive multimedia at the Georgia Institute of Technology, in order to improve impediments resulting from resource constraints as well as to enhance students' educational experience (May, 1996). Tsai (2009) has developed a courseware for semiconductor technology to overcome problems encountered in developing English Special Programs (ESP) in Taiwan. In the design of the whole courseware,

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five skills for learning English (listening, speaking, reading, writing, and translation) have been considered and a 3D multimedia technique has been used to promote learning interest, student engagement, and efficiency. Students report they have benefited from the courseware implementation. They report that the multimedia-assisted environment of the courseware promotes learning effectiveness.

Mastery learning using multimedia (Kazu *et al*., 2005) has positive effects on student understanding toward course content and the characteristic of user-friendly multimedia software served the purpose of student centered level of achievement and learning is optimized. It has been shown that animated graphic as teaching tool is more effective than traditional classroom teaching. It has been shown that animated graphic as teaching tool is more effective than traditional classroom teaching (Garcia *et al*., 2007; Mayer *et al*., 2004). Animated graphics as teaching tool in electrical/electronic engineering was tested to the students at University Tenaga Nasional Malaysia has showed the average score of students who were exposed to the visual presentation (89.69%) were better than the student without such exposure (54.68%). Semiconductor devices is one of the subjects in the field of material science taught in the Physics Department, Faculty of Science, Universiti Putra Malaysia. It requires a heavy use of the mind's imaginative and creativity faculty as well as the general analytical skills. This study is to develop an effective teaching aid, to improve the students' conceptual understanding a semiconductor devices. The main purpose of this study is to design and develop a computer courseware which serves as an e-book as a challenge towards e-learning (Khairi and Malvinder, 2006; Lundgren and Jonsson, 2005).

MATERIALS AND METHODS

The Fast Prototype Design Model is used to develop the software (Fig. 1). Macromedia Flash MX2004 is used to design 2D object, while Swift 3D is used to create 3D animation which is friendly in any compatible personal computer. Meanwhile, Adobe Photoshop is used to edit any necessary picture needed in software development. The project was carried out at the University Putra Malaysia from July 2009 to July 2010.

Experimental treatment (approach) and a set of questionnaire also be given to determine the applicable presentation of interface in multimedia development (King, 2002). To test the effectiveness of the courseware, the pre-test and post-test questionnaire were prepared and tested on the students before and after using the software. The test sheet consists of three sections,

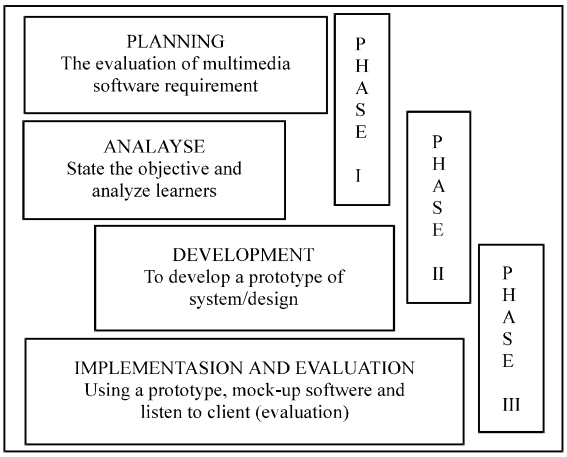

Fig. 1: The fast prototype design model as proposed by Tripp and Bichelmeyer (1990)

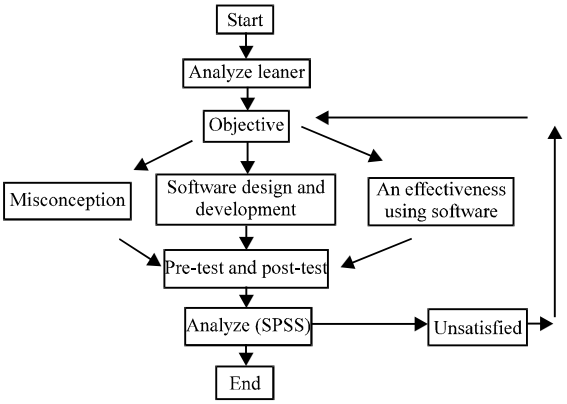

Fig. 2: Multimedia software development process

sections A are respondent information, section B are questions on semiconductors and section C are evaluation for the multimedia software. All the data are analyzed by using Statistical Package in Social Science For Windows (SPSS) version 12.

Figure 2 shows the research development of courseware and details are available elsewhere.

THE COURSEWARE

The interactive opening page shows all the content for Fundamental of Semiconductor Devices (Giancoli, 2005; Donald, 1996). It also provide a quick links to all the topics and subtopics. An exercise, question and a glossary are also included.

Introduction to Semiconductors covers the subtopics of crystal lattice, structural atom of silicon and

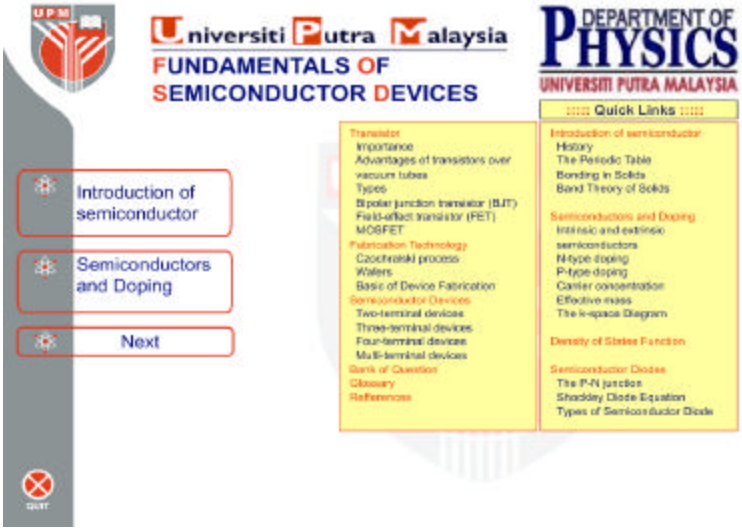

Fig. 3: Screen capture of opening page courseware

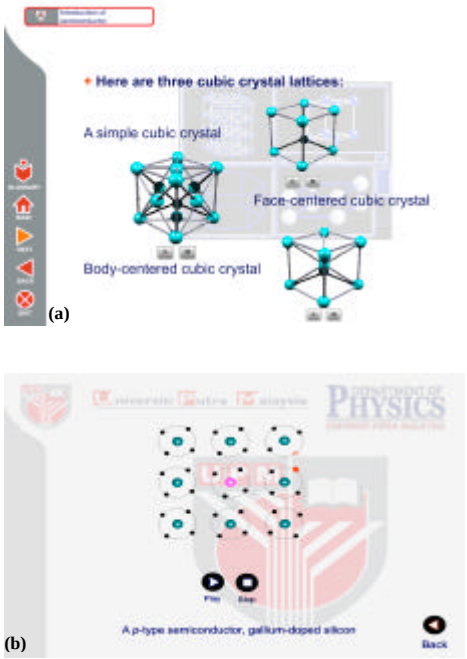

Fig. 4: (a) Animation in 3D for three cubic crystal lattice and (b) Animation in 2D to show a p-type semiconductor, gallium doped silicon

gallium (Fig. 3). The 3D animated graphic were used to visualize the simple cubic crystal, face-centered cubic crystal and body cubic crystal (Fig. 4a). The animation was also designed in 2D (Fig. 4b) to show a p-type semiconductor, gallium doped silicon.

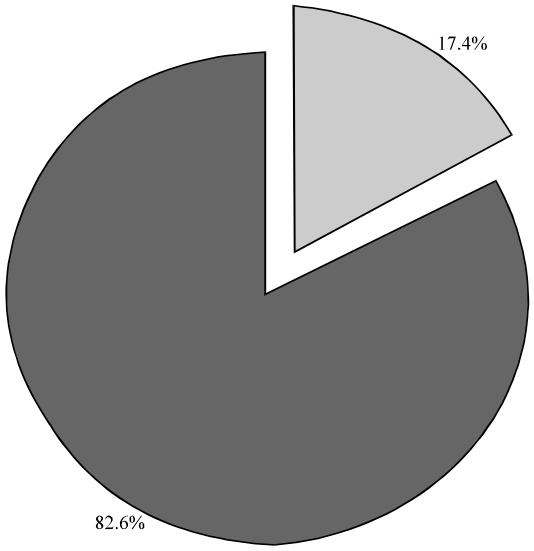

Fig. 5: The pie chart of test 1 PHY4202 course for first semester 2005/2006

RESULTS AND DISCUSSION

The result from the test 1 (Second Semester 2005/2006) shows more than 17.4% of students failed, which focused on the Fundamental of Semiconductor (Fig. 5). A set of questionnaire were distributed to the student at Physics Department, Faculty of Science, Universiti Putra Malaysia the First Semester 2006/2007, to determine problems face on specific and the result is shown in Fig 6. The Band Theory showed the highest

Table 1: Summary on gender and their majoring

				Majoring (%)		
Test	Gender	%	N	Physics	Instrumentation	Material science
1	Male	31.4	35.0	5.7	68.6	25.7
	Female	68.6				
2	Male	30.0	43.3	6.7	16.6	76.7
	Femal	56.7				

Table 2: Results of t-test of significance of differences in test scores with test value = 60

					95% Confidence interval of the difference	
	t	df	Sigma (2-tailed)	Mean of difference	Lower	Upper
Pre-test 1	0.77	34	0.4448	1.20	-1.98	0.38
Post-test 1	5.37	34	0.000*	4.91	2.74	6.04
Pre-test 2	0.76	29	0.455	0.67	-1.13	2.47
Post-test 2	4.69	29	0.000*	7.00	3.94	10.06

* = p<0.05

Table 3: Evaluation for the multimedia software

Item	Score	Standard deviation
Students perception towards on teaching and learning approach	4.23	0.75
Students perception about easy to navigate	4.34	0.62
Students perception on characteristics of multimedia	4.08	0.77
Students perception on designing of teaching	4.07	0.87
Students perception on designing of layout	4.09	0.77
Total mean of score	4.16	0.76

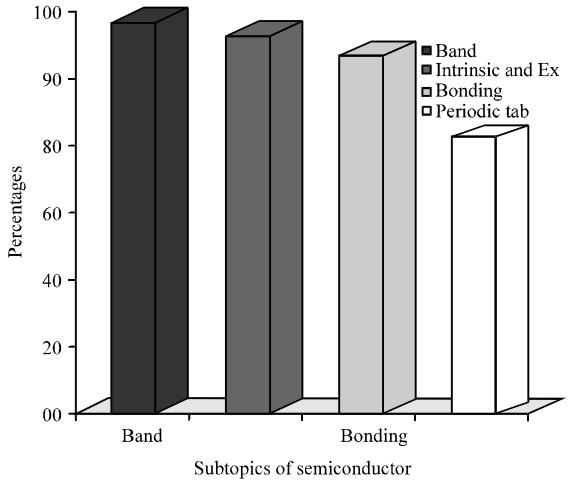

Fig. 6: Misconception on several topics in semiconductor devices course

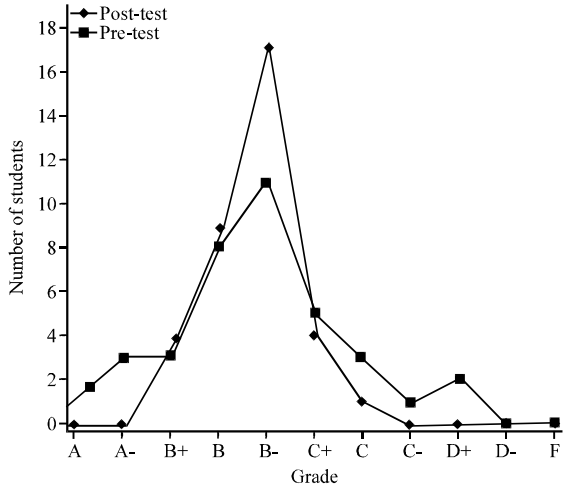

Fig. 7: The result of pre-test 1 and post-test 1 for pilot test

misconception, following with intrinsic and extrinsic semiconductor, bonding in solids and the periodic table. The best solution are to design and develop an appropriate multimedia software that can visualize the phenomenon inside the semiconductor.

The courseware was tested on the student as summarized in Table 1.

The results of the pre-test and post-test were shown in Fig. 7. It shows that after using the software the students understand better the semiconductor phenomena. The value (mean of grade) of post-test is 3.079 increases by 0.126 as compared with the pre-test (2.953).

A simple hypothesis which is relation to this research: Ho = no significant different between pre-test and post-test, Ha = significant different between pre-test and post-test and sigma (Sig) for post-test 1 with confidence interval is 0.000 (<0.05)*. So the Result = Reject Ho, caused of difference value between test, so using courseware in learning is effective and Ha can be accepted (Table 2).

Questionnaires on the students' perception towards the courseware were given to 30 students. As shown in Table 3, the study shows all five aspects of multimedia software can be accepted by learners with mean of score 4.16 and standard deviation 0.76. Students perception on navigation design shows the highest responses (m=4.34,

sd = 0.62), showing students are comfortable while accessing the courseware. Meanwhile the perception on designing of teaching materials shows the lowest score (m = 4.07, sd = 0.87), it need to be upgraded the result. Although this is a prototype courseware, all responses agreed with the total mean of score above 4.0, can be accepted.

CONCLUSION

A prototype courseware for fundamental of semiconductor devices for final year students majoring in Physics successfully developed. The results showed that the students performed better and accept the multimedia software in their learning session, with sigma value <0.05 for post-test 1 and post-test 2. Using Likert scale (total mean of score = 4.16 and sd = 0.76) with Alpha Croanbach of 0.89 (>0.7) concluded that the courseware is acceptable.

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