FIELD DEPENDENCE – INDEPENDENCE STUDENTS AND ANIMATION GRAPHIC COURSEWARE BASED INSTRUCTION

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Abstrak: Makalah ini melaporkan hasil kajian tentang kesan perisian animasi grafik terhadap pencapaian pelajar dalam mata pelajaran Sistem Elektronik di Politeknik Kementerian Pengajian Tinggi Malaysia. Kajian ini membandingkan pencapaian pelajar dengan kumpulan kawalan yang mengikuti pendekatan konvensional dan kumpulan yang mengalami pengajaran menggunakan perisian animasi grafik. Kajian dijalankan untuk membandingkan gaya kognitif, iaitu *field independent* (FI) dan *field dependent* (FD). Sampel kajian telah dipilih dalam kalangan pelajar semester pertama Diploma Kejuteraan Elektronik di Politeknik Merlimau, Melaka. Seramai 63 responden dipilih secara rawak. Kajian ini dilaksanakan secara kuasi-eksperimen, dan reka bentuk pra dan pasca ujian. Instrumen yang digunakan dalam kajian ini Ujian *Group Embedded Figures* (GEFT) untuk mengenal pasti pelajar FI dan FD adalah ujian pra-pasca, perisian animasi grafik, dan soal selidik. Data keseluruhan yang diperolehi diproses dengan menggunakan *Statistical Package for the Social Sciences* (SPSS) versi 12.0. Analisis data dilaksanakan dengan menggunakan statistik deskriptif seperti skor min dan frekuensi. Statistik inferential digunakan untuk menguji hipotesis pada paras 0.05. Ujian pra dan pasca dibandingkan untuk mendapatkan skor pencapaian pelajar dalam topik *Sine Wave Amplification Circuit*. Ujian parametrik terdiri daripada Ujian-t dan Kolerasi Pearson digunakan untuk analisis data. Analisis mendapati terdapat perbezaan yang signifikan dari segi pencapaian dalam kalangan pelajar kawalan dan pelajar yang menerima rawatan. Pelajar FI dalam kumpulan yang dirawat adalah lebih baik berbanding dengan kumpulan kawalan. Namun tidak terdapat perbezaan yang signifikan bagi pelajar FD dalam kumpulan rawatan yang sememangnya lebih baik daripada kumpulan kawalan. Kajian ini juga mendapati korelasi negatif yang lemah (r = - 0.318) antara pelajar FI dengan pelajar FD berdasarkan peningkatan skor. Perisian grafik animasi meliputi lima elemen iaitu mudah digunakan (min 4.16), reka bentuk *interface* (min 4.01) reka bentuk interaksi (min 3.83), bantuan berkaitan topik pembelajaran (min 3.86), dan motivasi (min 4.25). Sebagai penutup, implementasi perisian animasi grafik dalam proses pengajaran dan pembelajaran meningkatkan pencapaian pelajar dalam mata pelajaran Sistem Elektronik di Politeknik, yang mendapati pelajar FI beroleh lebih manfaat dalam pembelajaran.

INTRODUCTION

Each student learns in a different way and individual differences in learning have been corroborated in many studies. It has been argued that students learn in different ways, thus, instruction should be designed in such a way that it can accommodate different learning styles (Raven, *et al.*, 1993). The dimension of field dependence (FD) and field independence (FI) reflecting one's mode of perceiving, remembering, and thinking has emerged as the most widely studied cognitive style with the broadcast application to problems of education (Messick, 1976).

Cognitive styles can generally be described as stable attitudes, preferences or habitual strategies determining a person's typical modes of perceiving, remembering, thinking, and problem solving (Azizi, *et al.*, 2005). Cognitive style measures do not indicate the content of the information but simply how the brain perceives and processes the information. This study focuses on only two of the cognitive style constructs, FI and FD. Field independence – dependence is an established cognitive style that correlates with particular abilities and often predicts success in traditional and computer based instructional environments (Hall, 2000).

Witkin *et al.,* (1977) developed the concept of FD and FI to differentiate two distinct cognitive learning styles. Summerville (1999) referred to FI and FD dimensions as a global versus an articulated style that reflected the degree to which an individual's processing of information is affected by the contextual field. Mayer (2001) pointed out that the differences between FI and FD learners are more likely the result of 'varying information processing skills such as selective attention, short term memory encoding, and long term recall at which FI individuals are more accurate and efficient.'

Ennjoo Oh and Doohun Lim (2005) found that the level of field independency has a significant impact on the ways learners organize and navigate information, prioritize content, and develop meta cognitive strategies in computer based instruction. FD learners tend to be less successful in activities such as reorganizing and reproducing information, recognizing salient cues, and structuring information in computer based instruction than in classroom environments.

Research also found that individuals are different in their ways of seeking and processing information, and cognitive styles serve as a relatively stable indicator on how learners perceive and interpret information, and respond to learning environments (Lourdusamy, 1994). An FI person tends to perceive surroundings analytically, separating objects discretely from their backgrounds, while an FD person tends to perceive things in a relatively global fashion, being influenced by a prevailing field or context (Witkin *et al*., 1971). According to Witkin et al., (1977), FI and FD learners have different characteristics, as outlined in Table 1.

Table 1: Differences between Field Independent and Dependent Learners

Field Independent Learners	Field Dependent Learners
Analytic, competitive, independent, and individualistic	Sensitive to environments
Self defined goals, strategies, and reinforcement	Easily influenced by prevailing field or context
Intrinsically motivated	Group oriented, global, and socially-sensitive / prefer group project
Poor social skills / prefer individual projects	Prefer externally defined goals and reinforcements, and clear definitions of desired outcomes
Well organized and structured in their learning	Extrinsically motivated
Autonomous in cognitive restructuring skills	Less structured, less autonomous

On the other hand, other studies have found that there is no significant difference in students' learning outcomes based on their levels of field independency (Truell, 2001; Wang *et al.*, 2001). Cognitive styles are not correlated with their performance in classroom or computer based instruction. Summerville (1999) examined the effect of a hypermedia environment on 177 students enrolled in undergraduate technology

courses. Although the quantitative result did not yield significant differences in achievement and satisfaction scores, interviews revealed that FD learners preferred more step-by-step instructions with more human direction. FD learners need more social interaction and assistance in a hypermedia environment.

Liu and Reed's (1994) study showed that FI students tended to create their own structure while working with the hypermedia setting whereas FD students were more prone to follow the structure imposed by the software. In addition, FD students developed a more spectator and social approach to learning. FI learners are more analytical in their approach to processing information whereas FD learners are more likely to employ a more global visual approach to learning. Yea Ru Chuang (1999) examined the combination of animation, text, and voice on Mathematics achievement and found it affected FI students more than FD students. FI student obtained more benefits from the greater media complexity.

One of the most rapidly changing and exciting areas of education in the world today is the development of computer based teaching materials, especially multimedia that is used in teaching and learning. Multimedia is defined as a combination of various digital media types such as text, images, sound, and video into an integrated multi sensory interactive application or presentation to convey a message or information to the students (Jamalludin & Zaidatun, 2000). Furthermore, interactive multimedia can be a powerful learning and teaching tool because it engages multiple senses. Students using animation graphic courseware are reading, seeing, hearing, and actively manipulating materials. A multi sensory experience can be created for the audience, which in turn elicits positive attitudes toward the application. Multimedia has also been shown to elicit the highest rate of information retention and results in shorter learning time (Allesi & Trollip, 2001).

In other words, multimedia means "an individual or small group using a computer to interact with information that is represented in several media, by repeatedly selecting what to see and hear next". It is also interactive and enables the end users of the application to control the content and flow of information. Furthermore, animation graphic courseware as teaching aids usually integrates some combination of orientation tools. These kinds of tools further point to the major benefit of multimedia, the personalization or individualization of the learning experience. By allowing users to control the sequence and pacing of materials, animation graphic courseware facilitates greater individualization learning, allowing students to proceed at their own pace in a tailored learning environment. With multimedia technologies, this would make them active participants in their own learning process, instead of just being passive learners of educational content (Eun Mi Yang *et al.*, 2003).

Animation can function in two main ways to foster learning. First, they can have an effective function whereby they engage learner interest and sustain motivation (Siti Aishah *et al.*, 2004). The animations have another function of helping learners to understand and remember the content that they are required to study. This cognitive function is about facilitating the knowledge building process that is fundamental for effective learning. Well designed applications of multimedia, such as animation graphics enable students to come to understanding more quickly than through more conventional classroom or textual media. Animation graphic courseware is also an excellent aid for teachers when it comes to explaining a difficult subject. The difficulty of subjects may arise due to the involvement of mathematics or imagination.

Engineering subjects at Polytechnics, Ministry of Higher Education Malaysia, are divided into two categories: theory and practical. Students learn the theory and then they practice it at the laboratory to gain the engineering concept. The students fail to understand the concept in difficult subjects (Cockroff, 1986). According to Basco (1986), students are weak in the learning process mainly because they cannot remember or forget what they have learned. Implementation of computer based instruction in the teaching and learning process helps to solve problems faced by students in engineering subjects (Sahairil, 2003). The popularity of using animation to help learners understand and remember information has greatly increased since the advent of powerful animation graphic courseware.

The subject selected in this study is Electronic System, one of the Electrical and Electronic Engineering subjects at the polytechnic. Candidates have to pass this subject which is taught in the first semester of the Diploma in Electrical and Electronic Engineering. The Sine Wave Amplification Circuit topic in this subject contains a lot of theories and calculations. It is difficult to explain using texts only and students take a long time to understand these engineering concepts. Students have problems in imagining the operation process of the electrical circuit.

According to the Department of Examination, Polytechnic Sultan Azlan Shah (PSAS), the results of this subject for every semester are not satisfactory. Other than that, the rate of students who fail this subject is increasing every semester. Nin Hayati (2005) found that engineering students at polytechnics face difficulty in understanding the theory and calculation. This subject needs animation graphic courseware to explain the moving components and also current flow in an electrical circuit under the Sine Wave Amplification Circuit topic. Many topics in this subject contain moving components that need demonstration or dynamic teaching aids where students can understand better. According to Zol Bahri (2001), much research has been done on animation effectiveness as a learning aid in science subjects, but not in engineering subjects.

The most significant feature of the multiple forms of media is that they allow the presentation of knowledge in numerous ways. Thus, students can learn about abstract principles through text and see the application of those principles through an animation. These present the opportunity for a deeper level of understanding.

In order to teach successfully to a wide range of learners, instructors must recognize and promote the learning or cognitive styles of their students (Shahabuddin & Rohizani, 2003). Individual characteristics - found to be effective in terms of achievement and attitudes of the students, are also studied by many researchers who are interested in computer based instruction. If educators teach exclusively in one style, student's comfort level may be diminished and students may lose mental dexterity to think in different ways. The importance of individual differences and the truth that everybody can learn in specific instructional conditions force the researchers to find the most appropriate instructional condition for all kinds of learners.

RESEARCH QUESTIONS

This study has the following research questions:

a) Is there a significant difference in score gains in the achievement test among students learning using the animation graphic courseware and conventional method?

b) Is there a significant difference in score gains in the achievement test among Field Independent (FI) students learning using the animation graphic courseware and conventional method?

c) Is there a significant difference in score gains in the achievement test among Field Dependent (FD) students learning using the animation graphic courseware and conventional method?

d) Is there a significant difference in score gains between FI and FI students?

e) What are students' views (as measured on a Likert scale) on the elements of animation graphic courseware of Electronic System in helping them learn the subject?

METHODOLOGY

A quasi-experimental design method was used with a pre test and a post test. Respondents were divided into two groups; control group and treatment group. Pre test and post test were based on the Sine Wave Amplification Circuits topic. The pre test was given before teaching and learning process started in both groups. The control group followed the conventional teaching process while the treatment group used the animation graphic courseware. The pre test was used to measure students' prior knowledge based on Sine Wave Amplification Circuits topic at the beginning of the research. The post test was given to measure students' achievement after following that teaching and learning method. The students' score gain in their achievement was based on the comparison between the post test and pre test scores.

The population of this research was first semester students taking the Electronic System in the Diploma Electrical and Electronic Engineering course at the Electrical Engineering Department. The research was done at two polytechnics; Polytechnic Sultan Azlan Shah, Behrang as a treatment group and Polytechnic Merlimau, Melaka as a control group. The intake into all polytechnics is based on similar academic qualifications and the students can be considered to be of equal academic ability. All polytechnics use the same syllabus. Therefore, a sample taken from Polytechnic Sultan Azlan Shah and Polytechnic Merlimau Melaka were assumed to be representative of the population.

The instruments used in this research were Group Embedded Figures Test (GEFT), pre – post test, animation graphic courseware, and a questionnaire. The cognitive styles of the students were measured using the GEFT which was developed by Witkin et al. (1971) and translated and adapted into Bahasa Malaysia by Ng (1998). GEFT was designed to measure individuals' levels of field independency by tracing simple forms in the larger complex figures. The test instrument consists of three sections with 21 items: the first section contains three items for practice, and the second and third sections contain nine items each for scoring. The total score is the number of figures that are correctly traced in the second and third sections and possible maximum score is 18. People who tend to be Field Independence (FI) find the hidden figure more easily than the people who tend to be Field Dependent (FD). The reliability and validity of the test instrument has been proven by a number of studies over the years (typical reported coefficients are in the order of 0.82 – 0.90 can be found in the GEFT manual) (Witkin et al., 1971). For this study, the classification of the students according to their cognitive styles namely FD and FI is based on the scores. Students within a range of 0 – 9 were identified as FD. Respondents scoring 10 – 18 were identified as FI. Pre test and post test were used to evaluate the achievement after the teaching and learning process. The questions were developed based on the syllabus of the Electronic System subject. The questionnaire regarding the elements of animation graphic courseware (containing 20 questions) was developed by the researcher. The instrument composed five sub sections: easy usage of courseware, interface design, interaction design, helps to learn in topics, and motivation, using a five-point Likert Scale (5 = Strongly Agree, 4 = Agree, 3 = Not Sure, 2 = Disagree, 1 = Strongly

Disagree). Three experienced researchers in the instructional technology area reviewed the instrument to ensure the content validity of each survey item. The responses for the questionnaires were analyzed using Cronbach's Alpha tests in SPSS, and the results yielded a reliability estimation of 0.875of the survey.

RESULTS OF STUDY

Table 2: GEFT Test Score for Treatment and Control Group

Test Score GEFT	Treatment Group			Control Group			
	Sex		Total	Sex		Total	
	Male	Female		Male	Female		
0 - 9	6	0	6	1	5	6	Field Dependent
10 - 18	22	5	27	11	13	24	Field Independent
Total	28	5	33	12	18	30	

Table 2 contains the range of scores by category and the number of students in each category. Based on the scores, the students who scored 0 to 9 were defined as FD, and those who scored 10 – 18 were defined as FI learners. Of those 63 respondents, 51 (81%) students were identified as FI, and 12 (19%) as FD learners.

Table 3: ANOVA Homogeneity Test Score for Pre Test Treatment and Control

Pre Test	Sum of Squares	df	Mean Square	F	Significant
Between Groups	.000	1	.000	.000	1.000
Within Groups	1639.293	61	26.874		
Total	1639.293	62			

Table 3 shows the results of homogeneity pre test scores for the treatment and control groups. The result shows there is no significant difference between the treatment and control groups. Hence, prior knowledge between the two groups was the same on the Sine Wave Amplification Circuits topic in the Electronic System subject.

Table 4: Mean Score, Pre Test, Post Test, and Score Gain for Treatment and Control Group

Group	Pre Test	Post Test	Score Gain	
Treatment	3.6664	64.0261	60.3464	Mean
	33	33	33	N
	5.38100	22.53811	23.39245	Standard Deviation
Control	3.6663	31.1423	27.4760	Mean
	30	30	30	N
	4.95750	17.43007	14.56317	Standard Deviation
Total	3.6663	48.3671	44.6938	Mean
	63	63	63	N
	5.14200	26.04519	25.60235	Standard Deviation

Table 5: Result of T – Test

Group	N	Mean	Standard Deviation	t	df	Significant (2 tailed)
Treatment	33	60.3464	23.39245	6.616	61	0.000 p < 0.05
Control	30	27.476	14.56317			

T – Test results are shown in Table 4 and 5. The null hypothesis was rejected because p value is less than á (p = 0.00 < 0.05). There was a statistical significant difference in mean score gains between the treatment and control groups. Those students in the treatment group show a higher mean score.

Table 6: Mean Score, Pre Test, Post Test, and Score Gain among Field Independent (FI) Students for Treatment and Control Group

Field Independent Student	Pre Test	Post Test	Gain Score	
Treatment	3.5856 27 5.46970	65.6615 27 19.16824	62.0637 27 21.48831	Mean N Standard Deviation
Control	3.8092 24 5.25502	32.7971 24 17.33133	28.9879 24 14.36399	Mean N Standard Deviation
Total	3.6663 63 5.14200	48.3671 63 26.04519	44.6938 63 25.60235	Mean N Standard Deviation

Table 7: Result of T – Test

Group	N	Mean	Standard Deviation	t	df	Significant (2 tailed)
Treatment	27	62.0637	21.48831	6.377	49	0.000 p < 0.05
Control	24	28.9879	14.36399			

Table 6 and 7 shows the T - Test results for FI students between the treatment and control groups. The null hypothesis was rejected because p value is less than á (p = 0.00 < 0.05). There was a statistical significant difference in mean score gains between the treatment and control groups.

Table 8: Mean Score, Pre Test, Post Test, and Score Gain among Field Dependent (FD) Students for Treatment and Control Group

Field Dependent Student	Pre Test	Post Test	Gain Score	
Treatment	4.0300 6 5.43573	56.6667 6 35.50997	52.6183 6 31.83463	Mean N Standard Deviation
Control	3.0950 6 3.87634	24.5233 6 17.73812	21.4283 6 15.03816	Mean N Standard Deviation
Total	3.6663 63 5.14200	48.3671 63 26.04519	44.6938 63 25.60235	Mean N Standard Deviation

Table 9: Result of T - Test

Group	N	Mean	Standard Deviation	t	df	Significant (2 tailed)
Treatment	6	52.6183	31.83463	2.170	10	0.055 p > 0.05
Control	6	21.4283	15.03816			

Table 8 and 9 shows the T – Test results for FD students between treatment and control group. The null hypothesis was accepted because p value is greater than á (p = 0.055 > 0.05). There is no statistical significant difference in mean score gains in FD students between treatment and control group.

Table 10: Mean Score, Pre Test, Post Test, and Score Gain among FI – FD Students

Cognitive Styles	Pre Test	Post Test	Score Gain	
Field Independent (FI)	3.6908 51 5.31723	50.1959 51 24.57023	46.4986 51 24.75933	Mean N Standard Deviation
Field Dependent (FD)	3.5625 12 4.52758	40.5950 12 31.59053	37.0233 12 28.78825	Mean N Standard Deviation
Total	3.6663 63 5.14200	48.3671 63 26.04519	44.6938 63 25.60235	Mean N Standard Deviation

Table 11: Result of T – Test

Student	N	Mean	Standard Deviation	t	df	Significant (2 tailed)
Field Independent (FI)	51	46.4986	24.75933	1.157	61	0.252 p > 0.05
Field Dependent (FD)	12	37.0233	28.78825			

Table 10 and Table 11 show the T-Test results between two groups of students in FI-FD. Null hypothesis was rejected because p value is greater than á (p = 0.252 > 0.05). There was no statistical significant difference between the two cognitive styles of FI and FD students. But the FI students' achievement was better than FD students.

Table 12: Mean Scores for Elements of Animation Graphic Courseware

Bil	Elements	Mean Score
1.	Easy Usage of Courseware	4.16
2.	Interface Design	4.01
3.	Interaction Design	3.83
4.	Helps to Learn in Topics	3.86
5.	Motivation	4.25

As Table 12 indicates, the animation graphic courseware generally includes five elements, namely, easy usage of courseware (mean = 4.16), interface design (mean = 4.01), interaction design (mean = 3.83), helps to learn in topics (mean = 3.86), and motivation (mean = 4.25). The mean scores for the five elements are high. These elements helped students in their teaching and learning process in the Electronic System subject. The learners who used the animation graphic courseware in the teaching and learning process, strongly believed in the effectiveness and efficiency of the animation graphic courseware in improving their achievement.

DISCUSSION

In this study, analyses of the GEFT scores indicate that students tend to have different cognitive styles. Engineering students at polytechnics tend to be more field independent. This is consistent with earlier findings that the engineering students were field independent individuals (Witkin *et al*., 1977; Lourdusamy, 1994; Azizi *et al.*, 2005). Field independent students tend to choose academic majors that require cognitive restructuring skills, such as Engineering. Field dependent individuals tend to choose areas that require greater social and interpersonal involvement, such as Law and Humanities.

The achievement of students in the animation graphic courseware teaching and learning group is better than students in the conventional teaching group. This result supports the dual coding theory that when the material is being processed in separate channels (visual and verbal), it can be held into working memory at the same time (Mayer, 2001). It can be held there long enough for the students to make connections to prior knowledge which aids in the transfer of information and promotes constructivist

learning (Mayer and Anderson, 1992). Images of mental construction were assisted by the images shown on the computer screen during the learning (Mayer, 2001). Images help students build cognitive relationship between verbal and image information (Paivio & Clark, 1991). Animation is able to describe complex concepts to bring about easy and effective understanding (Sahairil, 2003).

The implementation of the animation graphic courseware in the teaching and learning process among FI students helps to improve in their learning achievement in the Sine Wave Amplification Circuit topic. The element of multimedia such as text, animation, audio, and graphic in instructional interface resulted in significantly better learning outcomes among FI students (Hsu, *et al.*, 1994; Yea Ru Chuang, 1999).

However, the animation graphic courseware in teaching and learning process among FD students does not help to improve their achievement compared to conventional teaching method. It is difficult for FD students to process and gain benefit from animation (Hsu, *et al*., 1994). According to Canino and Cicchelli (1988), FD students' achievement will increase when the students get more guidance from instructors. They are more likely to accept and encode the information presented without reorganization, restructuring, or revision. FD students have a global cognitive style because they are more ready to allow the external cues of an experience to point the way to understanding (Liu & Reed, 1994).

The findings from this research indicate that student's cognitive styles, FI-FD are not significantly correlated with student's learning achievement. On the other hand, other studies have found that there is positive correlation between the FI-FD cognitive style and achievement in science and mathematics (Kumar, 2003).

Lastly, this research found that the five elements (easy usage of courseware, interface design, interaction design, help in learning topics, and motivation) used to develop this animation graphic courseware help students to improve in their teaching and learning process in the Electronic System subject.

CONCLUSION

The animation graphic courseware as a teaching aid in the teaching and learning process helps students to improve their performance in the Electronic System subject at Polytechnics in Malaysia as compared to the conventional teaching and learning method. The use of the animation graphic courseware is an effective and innovative teaching and learning strategy because it motivates the students and helps them to understand and remember the complex concepts in the topics covered. Images help students to construct a cognitive relationship between verbal and visual information. Cognitive styles, Field Independent - Dependent, can also influence students' achievement in their learning process through the animation graphic courseware. From these findings, several recommendations can be made to improve the animation graphic courseware as a teaching aid for engineering students. Individual differences have to be considered when designing the courseware in education. The characteristics of FD students also have to be considered because the design of the courseware will increase learning in the engineering subjects.

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