EFFECTIVENESS OF USING GRAPHIC ANIMATION COURSEWARE FOR STUDENTS WITH DIFFERENT COGNITIVE STYLES AND SPATIAL VISUAL ABILITIES

Ahmad Rizal Madar[1] and Mohd Noor Hashim[2]

Faculty of Technical Education
Universiti Tun Hussein Onn Malaysia
Parit Raja, Batu Pahat, Johor
Malaysia

Email: [1]rizalm@uthm.edu.my, [2]mohdnoor@uthm.edu.my

ABSTRACT

This research was conducted to examine the effectiveness of using graphic animation courseware on pre and post test performance achievement in Electronic System 1 subject among students undergoing Certificate of Electrical and Electronic Engineering at the Malaysian Ministry of Higher Education Polytechnics. These students have different Cognitive Styles (Field Independent & Field Dependent) and Spatial Visual Abilities (High Visual and Low Visual). The achievement performance of this pre and post test was obtained from students who apply graphic animation courseware (experimental group) and conventional (control group) as their learning styles. The research samples comprised of 138 semester 1 students undergoing Certificate of Electrical and Electronic Engineering in the Department of Electrical Engineering, MOHE polytechnics. Two MOHE polytechnics were involved in this research, which are Central and Southern Zone. The experimental group consisted of students from Southern Zone, while the control group recruited students from Central Zone. Quasi-experimental with 2 x 2 factorial (Cognitive style x spatial visual ability) design was applied using quantitative data. Data collected were analysed using descriptive and inferential statistics which are mean, standard deviation, and independent samples T-test. A significant value of 0.05 was set for data reporting. Overall research finding shows that ; there was a significant difference in students achievement with Cognitive Styles of FI, FD, VT and VR where the experimental group were found better than the control group ; there was significant differences in the achievement of students with the characteristics of FIVT, FIVR, FDVT and FDVR where the experimental group showed a better result compared to the control group and ; the elements (Interface Design, Interaction Design, Motivation and User Friendliness) in the Electronic System 1 graphic animation courseware assist in students learning achievement. Overall, graphic animation courseware has the potential to improve students' achievement where those with the FIVT, FI and VT characteristics, will be benefited most.

Keywords: *Cognitive Ability, Field Dependent-Independent, Graphic Animation Courseware, Spatial Visualization Ability.*

1. Introduction

As a rapid advancement in Information and Communication Technology (ICT) that has benefited variety of business activities like agricultures, manufactures, administrative and even academic industry, educator has changed their vocational education method to electronic method (Rozinah, 2000). Technical and Vocational Education (PTV) was then being introduced for purposes of educating students required skills and knowledge (Robiah, 1994). According to Md. Shafiqul & Brauchle (2004), in order to being granted a good opportunity, technical graduates need to attach themselves appropriate working ethics. Hassan (2001) has defined polytechnics as tertiary academic institutions and they hold the responsibilities to contribute country a knowledgeable, skilful and presentable workforce.

1.1 Cognitive skills

According to Cognitive theory, Cognitive skills are the abilities students posed to store and from time to time, recall series of whilom information (Copper, 1998). Rakes (1999) has introduced *'Dual Coding'* theory that in virtue of multimedia to improve ability of memory power. This theory has further supported by other surveys (Mayer, 1989; Mayer & Gallini1990; Mayer & Anderson, 1991, 1992). Graphic Animation is useful for students that study Electronic System 1 subject for Engineering in Electric & Electronic in Polytechnic KPTM as this subject contain lots of theories and circuits that are hardly to explain verbally, on the other hand require appropriate visual supports to help students gain the insights. Azizi *et al*. (2005) has defined Cognitive Ability as ways how human arrange and implement mental activities that include represent, compile, acquire, incept, recall and utilize knowledge to acquainted and ravel out problems in orders to be secure under changeful environment. He further separated Cognitive Ability in two that were brilliant and ingenious according to how individual process, arrange and react for information received. As example, although a group of people who share a same knowledge for some circumstances, however, some of them will react very fast while other response slower. A research from Sorby *et al*., (2005) revealed four factors effecting students learning outcome. They are: Students' Family Background; Influence of Students' Accompanier; Students' Seminary; and Students' Characters (gender, memory power available, cognitive style, emotion quotient, knowledge obtained, and study methods). Students have their own study methods in memorizing, obtaining, remembering information. Researches by Yu-Ping (1997); Liu & Reed (1994); Jonassen & Hannum (1988) and Messick (1976) supported that Cognitive Ability dominate students' study methods. Another research from Tinajero & Paramo (1997) found that students who pose *Field Independent* will score good results for all subjects.

1.2.Field Independent-Dependent

Witkin *et al*., (1997) defined two types of Cognitive Ability into *Field Independent* (FI) and *Field Dependent* (FD). This statement was then further elaborated by Azizi *et al*., (2005) that individual who poses *Field Dependent* will incline in looking at elements than oversee the whole full picture. They like to focus on one aspect in a situation, imagine globally, able to work well in group, have good memory power in social information and show interest in literature and history subject. On the other hand, individual who poses *Field Independent* will incline in dismantle an issue into small parts to better analyse every component in detail. They not much interest, and yet they are not so good in social activities, but they are full of enthusiasm about mathematics and analysis-related activities. However, both *Field Independent* and *Field Dependent* share a common nature that they are able to score good result and explore their potential by computer based learning method (Parkinson & Redmond, 2002).

1.3 Visualization Skill

Visualization skill is the second ability to decide the effectiveness of '*Dual Coding*' theory. Utilization of visual system through animation technique provides a potential to build up visualization skill (McCuistion, 1991; Wiley, 1990) especially for those dynamic subjects (Lewalter, 2003). As examples, a research about 'Molecule Concept' found that teaching with animation graphics will improve students' retentivity than teaching without graphics (Norton & Sprague, 2001). Furthermore, a research carried out in Polytechnic

Sultan Ahmad Syah found that animation courseware will improve students comprehending in electric & electronic subject (Saifullizam & Sahairil, 2004). Other findings from researches in animation applications for Chemical subject have also concluded that animations are effective in improving students understanding about the subject (Sanger, 2000; Russel et al., 1997; Sanger & Greenbowe, 1997).

Dynamic visual information presentations through animation are more effective than using statistical graphics (Rieber, 1989) and texts (Hays, 1996). It is because computerized animation techniques help students to build their visual ability that able to clearly imagine processes of transformation or deportation of objects in sequence (Lewalter, 2003; Zsombor-Murray, 1990). There were several researches proofed that students who learned through animation will show a better understanding and comprehending than other student that underwent statistical graphics (Beak & Layne, 1998; Reiber, 1991; McCuistion, 1991).

1.4.Multimedia Courseware

A research carried out by Yea (1999) indicated that combination of animation, texts and sounds will effectively improve student learning outcome. Multimedia hold two advantages that are more reflexive learning material developed and more flexible study schedule (Najjar, 1996). Computer based multimedia courseware hold an interactive superiority to activate students' learning activities at all ages (Sewell, 1990). The more dynamic an interactive activity, the more active students' will behave in their learning processes (Toh, 1999). Through an active learning process, lots of advantages like better attention, prolong memorization, speed up learning process, and higher motivation will be achieve (Cotton, 1995; Reimer, 1992).

Baharuddin (2000) proposed that utilization of education technology supplements will improve effectiveness in teaching and learning processes as it demanded participation of seeing (75%); hearing (13%); touching (6%); feeling (3%) and smelling (3%). Multimedia Courseware pedagogy will magnetize students' sensations into their learning processes. In detail, students' vision, audition, feeling and mind are concentrated actively while they are ongoing their learning process (Vaughan, 1998). Among sensations discussed, vision is the most important sensation and holds the most impact in students' learning process.

Computer animation being defined as continuous changing in series of graphics along with timing and titles organized before (Park & Gittleman, 1992). Reiber & Hannafin (1998) defined animation as alteration of moving illustrations on computer screen. Sundberg (1998) defined computer animation as inflection of colour, brightness, size and shapes. While according to Jamalludin & Zaidatun (2000), animation represents processes of moving static images with variety of features. Besides, computerized animation can be presented by second dimension or third dimension. However, animations present in third dimension require higher and complex cognitive power.

1.5. Graphic Animation Courseware

One of the advantages of computerized animation is it able to clarify and simplify dynamic information to students (Norton & Sprague, 2001; Hays, 1996; Hofstetter, 1994; Reiber, 1991). There were several researches summed out effectiveness of computerized animation in deliver information, commentate abstracted concepts, draw attention, increase interest and motivation, neutralize dangerous or sensitive subjects and present complex information in little time (Lin & Dwyer, 2004; Doyle, 2001; Chan Lin, 2000; Horton & William, 1995; Niesen, 1995; Reiber, 1990). Researches also concluded animation will effective in presenting academic compendiums than text form (Hays, 1996), students don't need to repeatedly reading their textbooks to look for important points or understand what are the whole paragraph or topic discuss about (Catrambone & Seay, 2002; Brown *et al*., 1977). In short, animations ease up students' cognitive processes in presenting them clear and direct curriculums that will reduce demand in information process and memorization wastage (Reiber & Kini, 1991).

According to Clark & Taylor (1994), separate curriculums into components will relief students' cognition tensions for their studies. As it, animation courseware should include control buttons to separate curriculums into portions to allow students receive information according to their own cognitive ability. Besides, animation courseware will help students in controlling their time interacting with courseware. More time

spent with interaction process, more effective students will memorize information (Slater & Dwyer, 1996). Presenting information partially were concluded effective in educating students as they are more concentrate and allow to fully interact with information presented by animation (Fong, 2001).

Carpenter & Just (1992) and Safuan & Fong (2003) have found that graphic animation will improve students' academic achievements, another research from Ahmad Rizal & Jailani (2005) further supported students as machines that require ability to process and store important information for future usage. Besides, Charp (1996) stated multimedia courseware will attract students' attention, increase their curiosity, increase motivation and advocate creativity. Base on the statements, Safuan & Fong (2003) have concluded the effectiveness of animation as concepts are abstracted clearly and interactively to increase students' mastery for their studies.

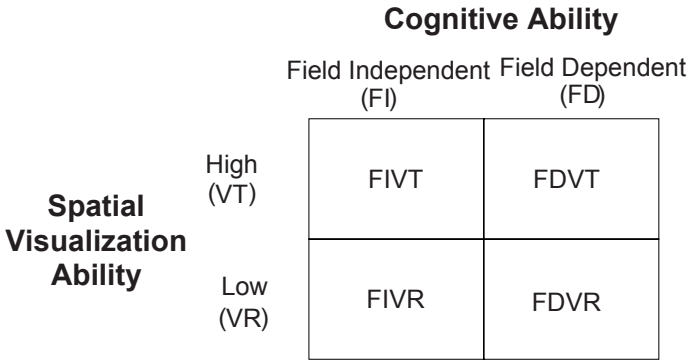
1. Method

2.1. Research Objective

Purpose of this research is to confirm and develop models to test effectiveness of Graphic Animation Courseware on students that pose different Cognitive Style *(FI & FD*) and Spatial Visual Ability (*VR & VT*) that undertake Electronic System 1 subject in Engineering in Electric & Electronic course at polytechnic KTPM.

2.2. Procedure

There was total population (N) of 220 students involved as respondents that undergoing their semester one: Engineering in Electric & Electronic 1 for Certificate in Electric & Electronic Engineering in two polytechnic that were Politeknik Johor Bahru (PJB) dan Politeknik Port Dickson (PPD). Actual samples for this research were 138 students. Respondents were given a *Group Embedded Figure Test* (GEFT) (Witkin *et. al.*, 1997) to identify their Cognitive Style (FI & FD) and *Spatial Visual Ability Test* (SVAT) (Maizam, 2002) to identify their Spatial Visual Ability (VT & VR). After that, respondents were divided into Control Group and Treatment Group according to results they scored. Each group contained four sub-groups that were FIVT, FIVR, FDVT and FVTR as shown in Graph 1 below.



Graph 2.1: Factorial Quasi Eksperiment 2 x 2

Pre-test and post test were given to both Control Group and Experimental Group to make sure all respondents shared same level of knowledge. For Experimental Group, respondents received three months graphic animation courseware-based pedagogy. Subsequently, the group were required to sit in post test. Independent Variable for this survey is Graphic Animation Courseware and Dependent Variable is discrepancy in results between respondents' pre-test and post test they underwent. A same method was employed on Control Group as well. Respondents from Control Group undertook their pre-test, followed by three months Conventional-based pedagogy. Photocopies and PowerPoint presentation were introduced

to this group as attractive elements. After their learning processes, they were required to sit for their post-test as well. Independent Variable for this survey is Conventional Pedagogies and Dependent Variable is discrepancy in results between respondents' pre-test and post test they took.

2.3. Test Instruments

Instrument for GEFT contained three parts that were exercises as part I and another nine items as part II and part III. This GEFT test has a total number of 18 items for respondents to identify complex geometric shapes. Instruments were designed visually and respondents were only need to read through instructions. Respondents who recognized more geometric shapes were categorised as FI while respondents who cannot recognized geometric shapes were categorised as FD (Hansen, 1995). Credibility of this instrument were proofed by several research years ago and were employed by Ennjoo & Doohun (2005) for their research in identifying relation between students' Cognitive Style and their aspect like behaviour, experience, and online-learning technology.

The second instrument employed for this research to distinguish respondents' Visual Ability was *Spatial Visual Ability Test* (SVAT). It was once employed by Somchai *et al*., (2005) that has revealed a significant difference in increased academic result from students who posed high visual ability among Experimental Group and Control Group. Besides, another research contributed by Nor Hanisha *et al*., (2006) also discovered effectuality of Graphic Animation Courseware in improving both High Visualization and Low Visualization students' academic results. This test contained 29 questions and organized into three parts. Part I contained 10 questions about cube construction, part II included 11 questions about Engineering Drawing and part III was comprised by 8 questions about Average Mental Ability.

Both Pre-test and Post-test required respondents to answer in written form as this form is the most regular used in testing students' Cognitive Style (Bott, 1996). Two types of questions were prepared. First types was 'Fill in the Blank' that was proofed effective in testing students' knowledge (Oosterlof, 1999; Bott, 1996; McMillan, 1997; Kubiszyn & Borich, 1996); while second type was Essay Writing was suitable to test students' Cognitive Style in a higher complexity level (Oosterlof, 1999; Bott, 1996; McMillan, 1997; Kubiszyn & Borich, 1996; Williams, 2000). The purposes of these pre-test and post test were to probe into student's academic achievements differentiated by their Cognitive Style (FI & FD) and Spatial Visual Ability (VT & VR) for their subject System Electronic 1 after underwent their studies (Graphic Animation Courseware or Conventional Pedagogy).

2. Results

Table 1 below brought forth research result for *t*-test and significant level. Hypothesis null being rejected as value p was less than significant level, α ($p = 0.000 < 0.05$). As a result, there was significant difference in mean score that indicated an improvement in achievement test for students who posed FIVT in Experimental Group and Control Group.

Table 1: Academic Achievement Analysis for FIVT Students

Group	N	Mean	Standard Deviation	*t*	df	Significant (2 end)
Experimental	19	72.1842	4.79934	4.483	35	0.000
Control	18	63	7.44786			p<0.05

Table 2 below showed research result for *t*-test and significant level. Hypothesis null being rejected as value p was less than significant level, α ($p = 0.000 < 0.05$). It concluded a significant difference in mean score to support an improvement in achievement test for students who posed FIVR in Experimental Group and Control Group.

Table 2: Academic Achievement Analysis for FIVR Students

Group	N	Mean	Standard Deviation	*t*	df	Significant (2 end)
Experimental	17	54.8824	9.79083	7.126	32	0.000
Control	17	37.0882	3.18314			p<0.05

Table 3 below also revealed the research result for *t*-test and significant level. For this analysis, hypothesis null being rejected as well since value p was less than significant level, α (p= 0.000 < 0.05), and threw out a significant difference in mean score to vouch for an improvement in achievement test for students who posed FDVT in Experimental Group and Control Group.

Table 3: Academic Achievement Analysis for FDVT Students

Group	N	Mean	Standard Deviation	*t*	df	Significant (2 end)
Experimental	16	58.7500	7.25259	7.176	30	0.000
Control	16	43.4375	4.50139			p<0.05

Lastly, table 4 below furnished out research result for *t*-test and significant level. Hypothesis null has being rejected as value p was less than significant level, α (p= 0.001 < 0.05) and asserted a significant difference in mean score for improvement in achievement test for students who posed FDVR in Experimental Group and Control Group.

Table 4: Academic Achievement Analysis for FDVR Students

Group	N	Mean	Standard Deviation	*t*	df	Significant (2 end)
Experimental	18	33.8611	6.87666	3.845	33	0.001
Control	17	26.3824	4.24091			p<0.05

3. Discussion

System Electronic 1 contains lots of theories and operational circuits that are hardly to elaborate by textbooks. From this research, an increase of academic performance has turn up by using Graphic Animation Courseware. It clearly shown that animation courseware is effective for teaching and learning processes that included flocks of theories that hardly elaborate and comprehend conventionally by Engineering students

Analysis indicated a significant statistical difference for improvement in achievement test among Control Group and Experimental Group that posed *Field Dependent* (FD) Cognitive Style. Mean score calculated has mirrored out students in Experimental Group with FD that underwent their studies by Graphic Animation Courseware have worked out better result than another group of students with FD that studied conventionally. Outcome of this research found corresponded with result proposed by Taylor (1980) in narrated attractiveness of animation courseware will increase *Field Dependent* students' motivation as it contain variety of components and charts for commendations.

Besides, result also revealed a significant improvement for students who posed high Spatial Visual Ability that underwent Graphic Animation Courseware pedagogy. Final mean score has declared effectiveness of the courseware to improve high Spatial Visual Ability students in their subject Electronic System 1. According to Mayer & Sims (1994), Spatial Visual Ability helps students to overlook objects, ponder in two or three dimension, and imagine configuration of the object. Hence, students who posed high Spatial Visual Ability are able to master imagination strategy than students with low Spatial Visual Ability.

Another analysis has carried out to identify any significant difference between students with low Spatial Visual Ability from Control Group that received conventional pedagogy and Experimental Group that received Graphic Animation Courseware. Result revealed a significant difference among two groups, and proofed the effectiveness of Graphic Animation Courseware in improving students with low Spatial Visual Ability to dominate their Electronic System 1. A research from Mayer & Sims (1994) stated that students with low Spatial Visual Ability will face difficulties in process and being benefited from animation than those students who posed high Spatial Visual Ability. Utilization of Graphic Animation Courseware will invite more than one sensation like vision, hearing, tactual, and mind from students to participate actively. It will hence bring a positive impact towards their learning process.

Refer to analysis discussed, it is clear to distinguish a significant difference in achievement test among Control Group and Experimental Group regardless what Cognitive Style or Spatial Visual Ability (FIVT, FIVR, FDVT and FVTR) they posed. These four combinations Cognitive Style and Spatial Visual Ability from Experimental Group coherently scored a higher Mean score than Control Group. In consequence, Graphic Animation Courseware is effective to improve students' academic performance by combining animations, texts and sound as part of teaching materials in order to profound their memorization process (Yea Ru Chuang, 1999).

Another finding of this research has verdict Graphic Animation Courseware as a pedagogy that will help instructors to pump up students' interest and attract their attention to learn. Furthermore, students are able to repeat topics they went through to further comprehend the knowledge and bear in their remembrance. Interest and motivation will lead a person to success. High interest and motivation turn up by students will directly result in higher academic achievements. Graphic Animation Courseware will increase students' interest and motivation by allows them to receive feedback almost at once and positively encourages them to submit their answers. Moreover, Graphic Animation Courseware confers students a higher interaction and involvement experience. Finding of this research was found similar with Saifullizam & Sahairil (2004) that proposed utilization of animation for Multimedia Courseware will motivate students in their learning process.

This research also covered effectiveness of elements of Graphic Animation Courseware for Electronic System 1 in improving students' learning progress. Overall, elements researched Interface Design, Interaction Design, Motivation and User Friendliness) have concluded that students were not facing any problems in using Graphic Animation Courseware for their teaching and learning processes. Purpose of using these elements in Graphic Animation Courseware is to increase message delivering quality and objective achievement rate. Graphic Animation Courseware allow students to learn aggressively as they find less hardness in comprehend theories, faster feedback, and easy to emphasis key points. Results were be analogous to findings from Hannafin & Hooper (1989) that stated utilization of multimedia elements will improve teaching and learning activities to more interesting, attracting, and efficient. Another finding from Khairul Hisham (2003) and Stephenson (1994) were found precisely the same as this research that equally concluded Graphic Animation Courseware will shorten time required by students to master their studies.

Lastly, this research revealed Graphic Animation Courseware was strongly effective in improving students' overall academic achievements in Electronic System 1. Consideration about individual differences should be count in when designing courseware or educational software. Multimedia should design to match individual learning method and information processing manner. Multimedia courseware should be customized to target groups to maximize information deliver by users. Graphic Animation Courseware that used in this research has shown its effectiveness in simplifying topic semiconductor that was said the most difficult among, where operation process of circuits and components were hardly understood by observing by eyes.

Ultimately, utilization of Graphic Animation Courseware will improve overall students' academic achievements for their subject Electronic System 1 in polytechnic KPTM. Proper utilization of multimedia elements will appropriate animation presentation will activate individuals' visual and verbal channel in mind and enhance obtaining, processing and storing of information. In addition, factors of individual difference in terms of Cognitive Style (FI & FD) and Spatial Visual Ability (VT & VR) also serve as factors that will effect students' academic achievements who receiving Graphic Animation Courseware pedagogy.

4. Conclusion

Based on the result obtained, it is clearly shown that Graphic Animation Courseware has effectively improved students' academic performance for their subject Electronic System 1 in polytechnic KPTM. It revealed features of Cognitive Style (FI & FD) and Spatial Visual Ability (VT & VR) posed by students also will impact effectiveness of Graphic Animation Courseware. Students that posed their own styles and abilities in FI, FD, VT, VR, FIVT, FIVR, FDVT and FDVR will reflected different academic achievements resulted from Graphic Animation Courseware that has slotted into their learning processes. These distinctions have to be highlighted to prevent any students being leftover from bestead of Graphic Animation Courseware. As it, curriculum planners from Curriculum Development Division, JPPKK, and KPTM should take in consideration for students' interpersonal factors that are Cognitive Style (FI & FD) and Spatial Visual Ability (VT & VR) when design Educational Graphic Animation Courseware. Besides, this research is important for Curriculum Development Division, JPPKK, and KPTM as pioneer to set up Graphic Animation Courseware for other Engineering subjects in polytechnic KPTM. It also serves as encouragement and revelation for instructors to further improve their technological knowledge and competency skills. Lastly, Graphic Animation Courseware Pedagogy concluded as another alternative for a more productive and better quality in technical education.

References

Ahmad Rizal Madar & Jailani Md. Yunus (2005). "Gaya Pembelajaran Visual Pelajar Teknikal Menerusi Pembangunan Koswer Berorientasikan Grafik dan Animasi." Prosiding Konvensyen Teknologi Pendidikan ke-18. Pusat Penerbitan Universiti (USM).

Azizi Yahaya, Asmah Suboh, Zurihanmi Zakariya, & Fawziah Yahya (2005). "Aplikasi Kognitif Dalam Pendidikan." Edisi pertama.Bentong, Pahang: PTS Professional.

Baharuddin Aris (2000). "Pendekatan Alternatif (Multimedia) dalam Pengajaran dan Pembelajaran Matematik: Pengalaman di UTM." Skudai: Universiti Teknologi Malaysia.

Beak, Y. K. & Layne, B. H. (1998). "Color, Graphic and Animation in a Computer Assisted Learning Tutorial Lesson." Journal of Computer Based Instruction, 15 (4), 131-135.

Bott, P.A. (1996). "Testing Assessment in Occupational and Tachnical Education." Needham Heights: Allyn & Bacon.

Brown, W.B., Lewis, R.B. & Harcleroad, F.F. (1977). "AV Instruction Technology, Media and Methods." (5th Edition). New York: McGraw-Hill.

Carpenter, P.A. & Just, M.A. (1992). "Understanding Mechanical System through Computer Animation and Kinematics Imagery." in Safuan Haji Rabaai and Fong, S.K (2003). "Kesan Animasi Berasaskan Komputer Terhadap Pembelajaran Bahasa Melayu." Malaysian Journal of Education Technology, 3(2), 17-24.

Catrambone, R. & Seay, A.F. (2002). "Using Animation to Help Students Learn Computer Algorithms." Human Factors, Fall 2002, 44 (3), 495-512.

Chan Lin, L.J. (2000). "Attributes of Animation for Learning Scientific Knowledge." Journal of Instructional Psychology, 27 (4), 228-238

Charp, S. (1996). "Interactive Multimedia." Technological Horizons in Education Journal, 23 (7), 6-10.

Clark, R.C. & Taylor, D. (1994). "The Causes and Cures of Learner Overload." Training, 31 (7), 40-43.

Cotton, J. (1995). "The Theory of Learning." London: Kogan Page.

Cooper, G. (1998). "Research into Cognitive Load Theory and Instructional Design at UNSW." Capaian maklumat pada 15 Disember 2006 dari http://education.arts.unsw.edu.au/CLT_NET_Aug_97.html

Doyle, C. (2001). "Making Your Module Accessible". Learning and Teaching Support Unit, University of Wales Institute Cardiff (UWIC). Capaian maklumat pada 09 Dis 2006 dari http://www.uwic.ac.uk/ltsu/5min_guide_module_accessible.html

Eunjoo Oh & Doohun Lim (2005). "Cross Relationships between Cognitive Styles and Learner Variables in Online Learning Environment." Journal of Interactive Online Learning, 4 (1), 53-66.

Fong Soon Fook, Ng Wai Kong & Wan Mohd Fauzy Wan Ismail (2001). "Persembahan Animasi : Perspektif Penting Untuk ICT Multimedia." Universiti Sains Malaysia : Jurnal Pendidik dan Pendidikan, 17, 14-23.

Hannafin, M.J. & Hooper, S. (1989). "Psychological Foundations of Instructional Design for Emerging Computer-based Instructional Technologies: Part 1." Educational Technology Research and Development Journal, 37 (2), 91-101.

Hansen, J.W. (1995). "Student Cognitive Styles in Postsecondry Technology Programs." Journal of technology Education, 6(2). Capaian Maklumat pada 15 Januari 2007 dari http://scholariib.vt.edu/ejournals/JTE/v6n2/jhansen.jte-v6n2.html

Hassan Said (2001). "Pendidikan Tertiari." Dalam Seminar Pembangunan Pendidikan 2001-2010. Kuala Lumpur: Kementerian Pendidikan Malaysia.
147-157.

Hays, T. (1996). "Spatial Abilities and the Effects of Computer Animation on Short Term and Long Term Comprehension." Journal of Educational Computing Research, 14, 139-155.

Hofstetter, F.T. (1994). "Multimedia Presentation Technology." California, Wadsworth.

Horton, W. (1995). "New Media Literacy: A Multimedia Bargain?" Technical Communication. Washington: Feb 1995. 42 (1), 194-197 (4).

Jamalludin Harun & Zaidatun Tasir (2000). "Pengenalan Kepada Multimedia." Kuala Lumpur, Venton Publishing.

Jonassen, D.H. & Hannum, W.H (1988). "Research-Based Principles for Designing Computer Software." Educational Technology, 12, 7-14.

Khairul Hisham Shahari (2003). Latihan Berasaskan Komputer (Computer Based Training). Prosiding Persidangan Pendidikan Teknikal Politeknik Kementerian Pendidikan Malaysia (1 – 3 Oktober 2003). 18 – 22.
.

Kubiszyn, T. & Borich, G. (1996). "Educational Testing and Measurement." New York, Harper Collins.

Lewalter, D. (2003). "Cognitive Strategies for Learning from Static and Dynamic Visuals." Learning and Instruction, 13, 177-189.

Lin, C.L. & Dwyer, F. (2004). "Effect of Varied Animated Enhancement Strategies in Facilitating Achievement of Different Educational Objectives." International Journal of Instructional Media. 31 (2). 185-199.

Liu, M. & Reed, M.R. (1994). "The Relationship Between Learning Strategies and Learning Styles in Hypermedia Environment." Computers in Human Behaviour, 4, 419-434.

Maizam Alias (2002). "Instructions on Spatial Skills and Spatial Visualization Ability in Engineering Students." International Education Journal, 3 (1), 1-12.

Mayer, R. E. (1989). "Systematic thinking fostered by illustrations in scientific text". Journal of Educational Psychology, 81, 240–246.

Mayer, R.E. & Gallini, J.K. (1990). "When is Illustration Worth Ten Thousand Words?" Journal of Educational Psychology, 82 (.4), 715-726.

Mayer, R.E. & Anderson, R.B. (1991). "Animations Need Narations: An Experimental Test of Dual-Coding Hypothesis." Journal of Educational Psychology, 83 (4), 484-490.

Mayer, R.E. & Anderson, R.B. (1992). "The Instructive Animation: Helping Students Build Connections Between Words and Pictures in Multimedia Learning." Journal of Educational Psychology, 84 (4), 444-452.

Mayer, R.E. & Sims, V.K. (1994). "For Whom Is A Picture Worth A Thousand Words? Extension of A Dual Coding Theory Of Multimedia Learning." Journal of Educational Psychology, 86 (3), 389-401.

McCuistion, P.J. (1991). "Static vs. Dynamic Visuals in Computer-Assisted Instruction." Engineering Design Graphics Journal, 55, 25-33

McMillan, J.H. (1997). "Classroom Assessment. Principle and Practice for Effective Instruction." Needham heights: Allyn & Bacon.

Md. Shafiqul Azam, & Brauchle, P. E. (2004). "Factorial Invariance of The Occupational Work Ethic Inventory (OWEI)." Journal Of Vocational Education Research, 29, 1-12.

Messick, S. (1976). "Human Spatial Abilities: Sources of Sex Differences." New York: Praeger. Capaian maklumat pada 2 September 2006 dari http://evolution.massey.ac.nz/lect18/lect1800.htm

Najjar, L.J. (1996). "Multimedia Information and Learning." Journal of Educational Multimedia and Hypermedia, 5, 129-150.

Nielson, J. (1995). "Multimedia for Hypertext: The Internet and Beyond. Boston, Academic Press dalam Liu M., Jones C. & Hemstreet S. (1998). Interactive Multimedia Design And Production Process." Journal of Research on Computing In Education. Washington: Spring 1998. 30 (3), 254-281.

Nor Hanisha Yusof, Ahmad Rizal Madar & Hashima Hamid (2006). "Hubungan Keupayaan Visualisasi Dengan Gaya Kognitif Pelajar Pendidikan Teknik & Vokasional Dalam Pembelajaran." Prosiding Seminar Pendidikan Pengajaran & Pembelajaran Bidang Pendidikan & Hospitaliti 2006.

Norton, P. & Sprague, D. (2001). "Technology for Teaching." Needham Heights: Allyn & Bacon.

Oosterlof, A. (1999). "Developing and Using Classroom Assessments" 2nd Edition. New Jersey, Prentice Hall.

Park, O. & Gittelman, S.S. (1992). "Selective Use of Animation and Feedback in Computer-Based Instruction." Educational Technology Research And Development, 40 (4), 27-38.

Parkinson, A. & Redmond, J.A (2002a). "Do Cognitive Styles Affect Learning Performance in Different Computer Media?" Dublin, Ireland: Department of Computer Science, Trinity College.

Parkinson, A. & Redmond, J.A (2002b). "The Impact of Cognitive Styles and Educational Computer Environments on Learning Performance." Dublin, Ireland: Department of Computer Science, Trinity College.

Rakes, G.C. (1999). "Teaching Visual Literacy In A Multimedia Age." TechTrends. 43 (4),14-18.

Reiber, L.P. & Hannafin, M.J. (1998). "Effects of Textual and Animated Orienting Activities and Practice on Learning From Computer Based Instruction." Computer in Schools, 5(1-2), 77-89.

Reiber, L.P. (1991). "Animation, Incidental Learning and Continuing Motivation." Journal of Educational Psychology, 83(3), 318-328.

Reiber, L.P. (1989). "A Review of Animation Research in Computer Based Instruction." Prosiding Kertas Kerja Pilihan 'Annual Meeting of The Association for Educational Communication and Technology'. Dallas, Texas. (ERIC Document Service No. ED 308 832).

Reiber, L.P. (1990). "Animation in a Computer Based Instruction." Educational Technology Research and Development, 38(1), 77-86.

Reiber, L.P. & Kini, A.S. (1991). "Theoretical Foundations of Instructional Applications Of Computer Generated Animated Visuals." Journal of Computer Based Instruction, 18(3), 83-88.

Reimer, K. (1992). “Taking The Active Route Means Better Results.” Computing Canada, 18:19. 51.

Robiah Sidin (1994). “Pendidikan di Malaysia: Cabaran untuk Masa Depan.” Kuala Lumpur: Penerbit Fajar Bakti Sdn. Bhd.

Rozinah Jamaludin (2000). “Multimedia dalam Pendidikan”. Kuala Lumpur, Utusan Publications & Distributors Sdn. Bhd.

Russell, J.W., Kozma, R.B., Jones, T., Wykoff , J., Marx, N. & Davis, J. (1997). “Use of Simultaneous-Syancronized Macroscopic, Microscip and Symbolic Representation to Enhance the Teaching and Learning of Chemical Concepts.” Journal of Chemical Education, 74, 330-334.

Safuan Haji Rabaai & Fong, S.K. (2003). “Kesan Animasi Berasaskan Komputer Terhadap Pembelajaran Bahasa Melayu.” Malaysian Journal of Educational Technology, 3(2), 17-24.

Saifullizam Puteh & Sahairil Azlan Sahidun (2004). “Penggunaan Animasi melalui Multimedia Interaktif dalam P&P Matapelajaran Elektrik dan Elektronik.” Prosiding Konvensyen Teknologi Pendidikan Ke-17 (17-20 Sept 2004). 77-84.

Sanger, M.J. (2000). “Using Particulate Drawings to Determine and Improve Students Conceptions of Pure Substances and Mixtures.” Journal of Chemical Education, 77, 762-766.

Sanger, M.J. & Greenbowe, T.J. (1997). “Students Misconceptions in Electrochemistry: Current in Electrolyte Solutions and Salt Bridge.” Journal of Chemical Education, 74, 819-823.

Sewell, D.S. (1990). “New Tools for New Minds.” Herthfordshire, Harvester Wheatsheaf.

Slater, R. B. & Dwyer, F. (1996). “The Effect of Varied Interactive Questioning Strategies in Completing Visualized Instruction.” International Journal of Instructional Media, 23 (3), 273-280.

Stephenson, S. D. (1994). “The Use of Small Group in Computer Based Training: A Review of Recent Literature.” Computers in Human Behaviour, 10, 243-259.

Somchai Enoi, Ahmad Rizal Madar & Jailani Md.Yunus (2005). “Keberkesanan Penggunaan Koswer Animasi Grafik dalam Mata Pelajaran Kejuruteraan.” Prosiding Seminar Kebangsaan ICT dalam Pendidikan 2005. Pusat Penerbitan Universiti (UPSI).

Sorby, S.A., Drummer, T., Hungwe, K., & Charlesworth, P. (2005). “Developing 3-D Spatial Vizualization Skills for Non-Engineering Students.” Paper presented at the 2005 American Society for Engineering Education Annual Conference & Exposition, Portland, Oregon.

Sundberg, P.A. (1998). “Animation in Call: Learning to Think in the Fourth Dimension.” Paper Presented: CALICO ’98 Symposium. San Diego, California. 9 Julai 1998.

Taylor, R.P. (Ed.). (1980). “The computer in the school: Tutor, tool, tutee.” New York: Teachers College Press.

Tinajero, C., & Paramo, M. F. (1997). “Field dependence-independence and academic achievement: A re-examination of their relationship.” British Journal of Educational Psychology, 67 (2), 199-212.

Toh, S.C. (1999). “Designing Effective Interactive Multimedia Courseware: Use and Misuse.” Prosiding Konvensyen Teknologi Pendidikan Ke-12 (8-10 Oktober, 1999). 205-213.

Vaughan, T. (1998). “Multimedia Making It Work.” (4th Edition). Berkeley, CA: Osborne/McGraw Hill.

Wiley, S. E. (1990). Computer graphics and the development of visual perception in engineering graphics curricula. The Engineering Design Graphics Journal, 54, (2), 39-43.

Williams, M.D. (2000). “Integrating Technology Into Teaching and Learning.” Singapore: Prentice Hall.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1997). "Field Dependent and Field Independent Cognitive Styles and Their Educational Implications." Review of Educational Research, 47, 1-64.

Yea, Ru Chuang (1999). "Teaching in a Multimedia Computer Environment: A Study of the Effects of Learning Style, Gender and Maths Achievement." Interactive Multimedia Electronic Journal of Computer Enhanced Learning.
Capaian maklumat pada Oktober 2006 dari
http://imej.wfu.edu/articles/1999/1/10/index.asp

Yu-ping Hsiao (1997) "The effects of cognitive styles and learning strategies in a hypermedia environment: A review of literature." Capaian maklumat pada Oktober 2006 dari http://www.edb.utexas.edu/mmresearch/Students97/Hsiao.

Zsombor-Murray P.J. (1990). "2-D and 3-D CAD: Complements To Visualization." Engineering Design Graphics Journal, 54 (3),17-29.