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THE EFFECT OF MULTIMEDIA-BASED TEACHING MATERIALS IN SCIENCE TOWARD STUDENTS' COGNITIVE IMPROVEMENT

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ABSTRACT

This study is a meta-analysis study that aimed to determine the effect of multimedia-based teaching materials in science learning to students' cognitive enhancement. This study integrated primary study results of several studies that had been published in national and international journals. The method used in this research was the analysis of the results of seven international journals and three national journals involving multimedia teaching materials based on science learning as the main study. Searches were done through the search engine Google, using Eric Journal and Google scholar with keyword multimedia-based teaching materials. Analysis of data was the description of the results of the average effect size of each study sampled then categorized based on Cohen's interpretation. The results showed that multimedia-based teaching materials in science learning had a significant influence on students' cognitive learning outcomes indicated by the average effect size of 0.78. Differences in cognitive enhancement were based on a group of countries, fields of study, education level and the variety of multimedia teaching materials. It was concluded that the multimedia-based teaching materials in science learning showed a significant effect on students' cognitive enhancement.

Keywords: meta-analysis, multimedia teaching materials, students' cognitive.

INTRODUCTION

Natural Science is a vehicle for students to learn about objects and natural phenomena based on the thoughts, observations and investigations (Ministry of Education and Culture, 2014). Science does not only cover scientific knowledge, but also contains important scientific dimensions that includes content dimension in the form of facts, concepts, laws and theories, and the dimensions of the scientific process (Liliasari & Tawil, 2014).

Science is a knowledge to develop scientific understanding through research activities, so that students are able to explain, evaluate and build scientific knowledge independently (Duschl, et al., 2007).

The quality of science teaching in some countries, at the moment is still relatively low. This is reflected in the results of the analysis of the ability of students' science achievement in several international studies such as TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Students Assessment). Based on the TIMSS science achievement data mapping in 2011, there were 24 of the 42 participating countries are in a position below the international average score scoring less than 500 (IEA, 2012). Furthermore, based on the results of PISA in 2012 there were 40 of the 65 participating countries also had an average science achievement scores below the international average score under 501 (OECD, 2013).

The low achievement in science in some countries is partly due to the less maximal of students' cognitive abilities development. Cognitive ability is not a natural skill but a process and a product of mind to attain knowledge in the form of

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mental activities like remembering, symbolizing, categorizing and solving problems (Hamalik, 2011). Cognitive Domain in Bloom's Taxonomy mentions six kinds of capabilities that are arranged in a hierarchy ranging from the simplest to the complex, they are: knowledge, comprehension, application, analysis, synthesis and evaluation (Vieyra, 2006). One cause of low cognitive abilities of students is the teaching materials used in teaching (Djamarah & Zain, 2014). Many teaching materials only copy information from one of to others, so that students have a tendency to memorize. Teachers need appropriate media to attract students' attention during learning, processing complicated and complex teaching materials into simple and clear ones, and reverting abstract scientific concepts into the concrete ones (Ministry of National Education, 2007). Concrete concepts in learning become fundamental to clarify the abstract facts (Hill & Korhonen, 2014). Attractive teaching materials are potential to increase the students' cognitive processes (Koning, et al., 2009). The effectiveness and efficiency of the learning process can be improved through the application of multimedia teaching materials (Siagian, et al., 2014).

Multimedia includes various combinations of text, images, graphics, animation and video elements that have been digitally manipulated so as to display a fun projection, having aesthetic value and maintaining visual consistency (Ivers & Baron, 2010). Students receive multimedia-based learning information through both spoken and text as well as information through images such as animations or illustrations (Mayer, 2003). Application of multimedia learning can increase high-level thinking skill, problem solving skill and students' cognitive (Stoney & Oliver, 1999). Multimedia greatly contributes to the effectiveness of learning as well as the delivery of messages and content, thus helping students to enhance their understanding and ability to think (Fitriana, 2011).

Research on multimedia learning has been widely carried out, thus requiring a comprehensive assessment. This study aimed to determine the effect of multimedia-based teaching materials in science learning toward students' cognitive improvement. It was conducted through several discussions in general, regional countries, subjects, education levels and learning media.

METHOD

The method in this study was a meta-analysis by reviewing the results of several educational journals (Merriyana, 2006). The collection of data obtained from 10 journals on education includes seven international journals and three national journals, while the journals were searched through google search engines included Eric Journal and Google Scholar with the main study of multimedia-based teaching materials.

Analysis of the data used a description of the average effect size of each study. The applied formula of effect size was Delta Glass (Glass, 1976). The effect sizes results was then categorized based on Cohen's interpretation as follows:

Table 1. Category of *Effect Size*

Cohen's Standard	***Effect Size***
Large	0,6 – 2,0
Medium	0,3 – 0,5
Small	0,0 – 0,2

Cohen (1988)

RESULT AND DISCUSSION

The discussion in this research comprehensively covers general study, regional countries, science disciplines, education levels and learning media.

Based on data from Table 2, it showed that the average effect size was 0.78. This shows that the multimedia-based teaching materials in science learning can improve cognitive achievement of students with the category of "high" (Cohen, 1988). Learning by using multimedia-based teaching materials make it easier for students to understand the concept (Zahra, 2015). Students can learn the abstract concepts using multimedia-based teaching materials so as to clarify those (Ministry of National Education, 2007). Multimedia-based teaching materials can improve the construction of knowledge, synthesis skill as well as build bridges between knowledge (Schrader & Raff, 2015). Abstract concepts in physics will be more easily understood when students acquire multimedia learning (Liu 2006 & Wiyono, 2009).

The results of analysis of multimedia teaching materials presented through a variety of ways, including text, graphics, images, audio, video and animation (Table 2). Students will learn more effectively when learning information is processed through various means (Rahman, 2011). The concept of liver function is easier to understand when students use multimedia graphics, while the blood circulation system is presented in text, video and animation (Brunken et al., 2003). Presentation of learning informati-

Table 2. Characteristic of Research Data and Effect Size.

No.	Researcher	Country	Subjects	Level	Experiment	Control	Discussion	Total Respondents	Effect Size
1.	Li Zhu and Barbara Grabowski	Pennsylvania	Biology	Senior High School	Animation & Elaboration Strategy	Graphic Pictures	Concept Understanding	115	0,30
2.	Bradley D. Ausman, Huifen Lin, dan Kusro Kidwai	Pennsylvania	Biology	University	Proggresive Animation	Animation	Concept Understanding	88	0,80
3.	Carol Koroghlanian dan James D. Klein	Arizona	Biology	Senior High School	Audio – Animation	Audio Text	Concept Understanding	109	0,5
4.	Wira Udaibah	Indonesia	Chemistry	University	Animation – Power Point	Conventional	Achievement and Learning Motivation	40	0,92
5.	Gokhan Aksoy	Turki	Physics	Elementary School	Computer Animation	Traditional	Learning Outcomes	60	1,00
6.	Slamet Rahayu, Wardi dan Sucipto	Indonesia	Biology	Junior High School	Flash Animation	Power Point	Learning Outcomes	64	0,65
7.	Ananta Kumar Jena	India	Biology	Elementary School	Computer Animation	Traditional Teaching	Learning Outcomes	52	0,84
8.	Agnaldo Pedra, Richard E. Mayer dan AlbertoLuiz Albertin	Brazil	Physics	University	Interractive Technic Animation	Non-Interractive	Learning Outcomes	68	1,06
9.	Hsin I.Yung dan Fred Pass	Taiwan	Biology	Junior High School	Pedagogic Animation	Non-Pedagogic Animation	Cognitive Mastery	133	0,53
10.	I Nyoman Haryanto	Indonesia	Biology	Special Needs Junior High School	Animation Video	Traditional	Learning Outcomes and Creativity	20	1,19
	Mean								**0,78**

on through text, graphics, images, audio, video and animation also relates to the use of the five senses. Students' understanding will be better if the lesson presented by integrating the senses of sight and hearing compared by only using the sense of sight (Mayer, 2001).

Results of research by Haryanto (2015) involved students of junior high school with special needs as a sample. This research has the highest effect size (1.19) compared to other research (Table 2). Characteristics of his study sample are below normal students with the Intelligence Quotient (IQ) of less than 79 (Somantri, 2006). Teaching materials in Haryanto's research (2015) were presented through video animation on the concept of the body frame and the human senses. The results showed that an animated video teaching material can improve cognitive learning outcomes of students. Animated video teaching materials are more capable to stimulate thoughts, feelings, concerns and learning willingness of students (Ministry of National Education, 2007). Multimedia teaching material can input and exchange various types of information and knowledge into students' minds more widely (Jalali, et al., 2015). Learning effectiveness can be maximized through multimedia learning (Najjar, 1998).

The results of data analysis also showed the influence of multimedia teaching materials to students' cognitive improvement in several count-

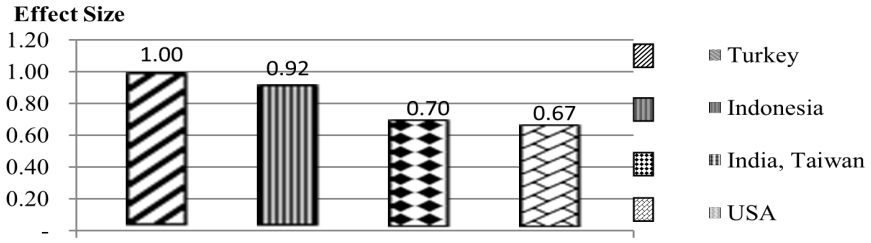

Figure 1. Mean of Effect Size in Several Countries

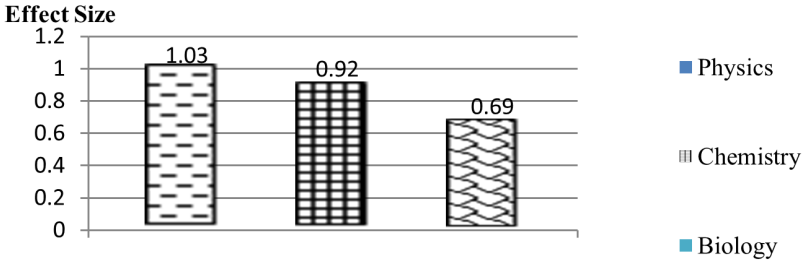

Figure 2. Means of Effect Size on Science Subjects

ries including Indonesia, USA, Turkey, India and Taiwan.

The average effect size of influence of multimedia teaching materials toward students' cognitive enhancement in Indonesia and Turkey were higher than the US, India and Taiwan (Figure 1). This was due to the control class research in Indonesia and Turkey used different teaching materials from the experimental class. Control classes were not given multimedia-based teaching materials so that it gives a very significant effect on students' cognitive enhancement. Multimedia developments in Indonesia started since the erection of Satelindo in 1993. This progress was marked with the publication of 2210 of multimedia-based educational journals. Meanwhile, based on the results of the data mapping by PISA in 2012, Turkey ranked 44th out of 65 participating countries (OECD, 2013). This fact had pushed the Turkish government to reform the education (Gencer & Cakiroglu, 2005; Dogan & El Khalick 2008 and Cikmaz, 2014).

Based on the facts, it was concluded that the multimedia development in Indonesia and Turkey used new technology. Through new learning climate, Indonesia and Turkey are capable of increasing students' interest and motivation, thus providing a positive influence on the learning outcome (Djamarah & Zain, 2014). Motivation is the driving engine that can accelerate the success of the learning process (Hamalik, 2011).

Meanwhile, the control classes in various researches of India, Taiwan and the USA were also applied multimedia-based teaching materials (e.g. images, graphics, animation and audio) and therefore it contributed less significant to increase students' cognitive, characterized by low average of effect size (Figure 1).

Multimedia systems of USA began in the late 1980s with the introduction of Hypercard by Apple. The progress of multimedia in USA has been marked by the issuance of 16,600 multimedia-based research journals. Developed countries like USA had reformed scientific education in the end of last century (NRC, 1996). Based on these facts, we can conclude that multimedia system in USA was often used in the learning process, but it caused students to feel bored since the multimedia used repetitively, thus lowered students' interest towards learning. Learning with interest will encourage students to learn better than learning without interest (Hamalik, 2011). Learning interest is able to encourage the emergence of student motivation to learn. Motivation affects the process of interaction between students and learning materials (Sardiman, 2014). Students' progress in learning motivation is an important element that involves mental and physical activity (Johnsto, 2013 & Naor, et al., 2014).

The results of data analysis also showed the influence of multimedia-based teaching materials to students' cognitive enhancement in various disciplines of science: physics, chemistry and biology (Figure 2).

Based on Figure 2, it was discovered that the means of effect size of influence of multimedia teaching materials toward physics, chemistry and biology, belongs to the "high" category (Cohen, 1988). Physics materials in these studies were the solar system and engineering, the chemistry material was metal structures and the biology materials included parts and functions of

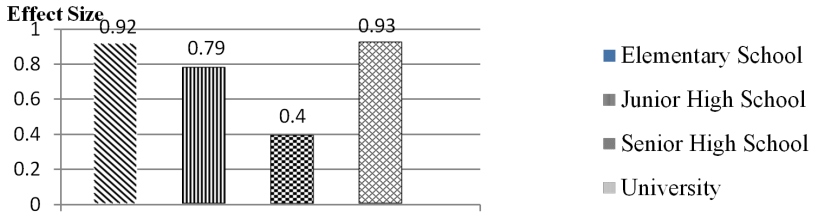

Figure 3. Means of Effect Size on Various Education Level

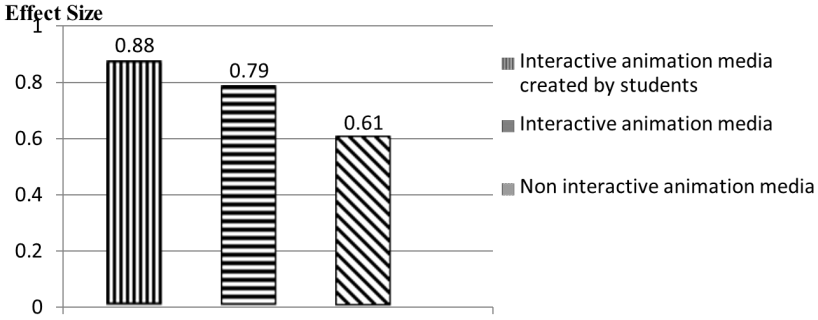

Figure 4. Means of Size Effect of Various Media

the human heart, the circulatory system, the cycle of blood pressure, cell system, digestive system, the body frame and the five senses as well as the human cardiovascular system. Based on above data, it showed that the subject matter of physics, chemistry and biology were mostly abstract concepts. Learning to use the abstract concepts in general the students could only imagine the existence of the matter. Most of students are not able to construct knowledge and understand the material independently so they fail to learn (Hill & Korhonen, 2014). Students' understanding of abstract concepts can be found out through the provision of open-ended questions (Wang, et al., 2012). Teachers play an active role as a facilitator to facilitate students to learn and develop the knowledge (Mahfouz, 2012). Teachers can process abstract concepts through multimedia-based teaching materials into a concrete concept (Ministry of National Education, 2007). Abstract concepts in biology materials will be more easily understood when students use multimedia learning (Pratiwi, 2011).

Various concepts, principles and theories of science are essentially a product obtained through systematic and planned process (Curriculum and Book Research and Development Center, 2014). The concepts of science in general are interconnected; so as to understand a concept, the students first should understand the previous concept. Multimedia teaching materials can help students in describing relationships between concepts and the process of science (Ministry of National Education, 2007).

Based on Figure 3, the effects of multimedia teaching materials in elementary education level students gained an average of 0.92 effect size category "high" (Cohen, 1988). This showed that the multimedia-based teaching materials have a very significant effect on cognitive enhancement of elementary students.

Based on Piaget's Theory of Cognitive Development, students aged 7 to 12 years old are at the stage of concrete operations, so that the students are able to solve the problem logically with the help of concrete concepts and objects (Huitt & Hummel, 2003).

Learning must be tailored to the students' level of cognitive development, for example in the stage of concrete operations the students should learn with the materials that constitute live experience as well as the problems and concrete objects (Sungur et al., 2001). Internal mental activity during the learning has enabled students to modify and organize images and symbols in order to reach logical conclusion (Shaffer & Kipp, 2010).

Figure 3 also showed the multimedia teaching materials on the SMP had "high" category by effect size of 0.79 (Cohen, 1988). Junior high school students (12 to 15 years old) are at the stage of cognitive development of concrete operations towards formal operations (Huitt & Hummel, 2003). Learning using multimedia-based teaching materials can develop their intellectual ability to think on concrete objects (Ministry of National Education, 2007). Effect size for junior high school students was smaller than those for elementary school students (Figure 3). There are still many 12 years old students and older who have not yet reached the stage of formal opera-

tions, this happens because of the level of intellectual development is not only determined by the age factor alone but also influenced by maturity, physical experience, math-logic experience, social transmission and the process of balance or self-regulation (Dahar, 1996).

The average of effect size of multimedia teaching materials at high school students was 0.40 (Figure 3). The data was categorized as "moderate". This meant that multimedia teaching materials do not significantly influence the cognitive development of high school students. High school students (15 to 18 years old) are at the mid-teens stage, which is a transition stage between early adolescents aged 12 to 15 years and the late teen aged 18 to 21 years (Yusuf 2008).

Based on Piaget's Theory of Cognitive Development, senior high school students are at the stage of formal operations. In this stage, students are able to think logically for different types of hypotheses, verbal problems, deductive and inductive thinking and the use of scientific reasoning and they are also capable to accept the views of others (Huitt & Hummel, 2003). High school students do not only have the ability to think on a concrete concept, but they can also develop the ability to think in abstract concepts (Krause, et al., 2007 & Sungur, et al., 2001). High school students in general have a higher intellectual development than junior high school students, so they should have a better mastery of concepts. But the results of data analysis showed that the average effect size of high school students is lower than junior high school students (Figure 3). High school students have the cognitive abilities that are well developed to be able to cope with stress or emotional fluctuation effectively. But in reality there are many high school students who have not been able to manage their emotions, depressed, grumpy and less capable to regulate themselves. These conditions lead to various problems, including learning difficulties that affect the improvement of students' cognitive abilities (Yusuf, 2008).

Based on Figure 3, the data analysis the average effect size level of the university students was 0.93. This data is categorized as "high" (Cohen, 1988). This showed that the multimedia-based teaching materials play very significant influence on student cognitive enhancement. Students at the university level are at the stage of late adolescence between 18 to 21 years old (Yusuf, 2008).

Based on Piaget's Theory of Cognitive Development, students at the university level belong to the stage of formal operations (Huitt & Hummel, 2003). Mastery of biology concepts at the development level of formal operations is significantly better than students at the level of concrete operations (Okoye, et al., 2008).

The average effect size data showed that university level has the highest score. It is not only related to age alone but it is also determined by the intellectual development, a way of thinking based on the awareness and skill to test hypotheses and scientific reasoning (Yusuf, 2008).

In general the media in this study belonged to the audiovisual motion media or animation (Figure 4). Audiovisual media can show an element of sound (audio) and moving images (visual) (Djamarah & Zain, 2014). Multimedia program includes several important elements include text, images, video, animation, sound, interractive and user controls (Ivers & Baron, 2010).

Multimedia type in this study was interactive multimedia (picture 4). Interactive multimedia was equipped with a controller operated by a computer user to select the desired effect to continue the process of the next program.

The results of data analysis showed that the average effect size interactive animations media created by students was higher than other media, with a score of 0.88 (figure 4). This shows that interactive animation media made by the students has significant effect on students' cognitive improvement compared to other media. Interactive multimedia can increase effectiveness and efficiency of learning (Siagian, et al., 2014). It can also illustrates various concepts to achieve specific learning objectives (Ferguson et al., 2015).

Learning activities of students through interactive multimedia activities is not just a viewing activity, but also a variety of other activities such as listening, observing and discussing, so that the students' knowledge increased significantly (Ministry of National Education, 2007). The data even showed that interactive media created by the students would have a higher effect size than the ones created by the teacher. The best way to study is through speaking activity which contributes to 90% in terms of the understanding, while the activity of talking accounts for 70%, seeing and hearing contribute 50%, the viewing activity helps 30%, hearing gives 20% while reading adds only 10% of the student's total understanding (Magnesen, 1983).

CONCLUSION

Based on the analysis, the researcher concludes that:

a. Multimedia teaching materials emerged a very significant influence on students' cognitive

improvement with the effect size of 0.78.

b. Multimedia teaching materials caused a very significant influence in Indonesia and Turkey with the effect size of 1.00 and 0.92.
c. Multimedia teaching materials gave the most significant effect on the subjects of physics with the effect size of 1.03.
d. Multimedia teaching materials brought a very significant influence on the university level, with the effect size of 0.93.
e. Interactive media created by students played more significant effect on students' cognitive improvement with the effect size of 0.88.

REFERENCES

Abdurrahman. (2011). Penggunaan Multipel Representasi pada Penyusunan Argumen untuk Meningkatkan Penguasaan Konsep Fisika Kuantum. *Jurnal Penelitian Pendidikan IPA,* 5(1), 8-14.

Brunken, Roland., Plass, L.Jan & Leutner, Detlev. (2003). *Direct Measurement of Cognitive Load in Multimedia Learning.* Germany: Departement of Psychology Erfart University.

Cikmaz, Ali. (2014). *Examining Two Turkish Teacher's Questioning Pattern in Secondary School Science Classroom.* Lowa: University of Lowa.

Cohen, Jacob. (1988). *Statistical Power Analysis for The Behavioral Sciences (2nd ed).* Hillslade. NJ: Lawrence Erlbaum Associates.

Dahar, Ratna Wilis. (1996). *Teori-Teori Belajar.* Jakarta: Erlangga.

Depdiknas. (2007). *Buku Panduan Pengembangan Multimedia Pembelajaran.* Jakarta: Direktorat Pembinaan Sekolah Mengah Atas. Departemen Pendidikan Nasional.

Djamarah, Syaiful Bahri & Zain, Aswan. (2014). *Strategi Belajar Mengajar.* Jakarta: Rineka cipta.

Dogan, Nihal & El Khalick, Abd Fouad. (2008). *Turkish Grade 10 Student's and Science Teacher's Conceptions of Nature of Science : A National Study.* Turkey : Department of Science Education. Abant Izzet Baysal University.

Duschl, A. Richard., Schweingruber, A. Heidi., Shouse W. Andrew. (2007). *Taking Science to School: Learning and Teaching Science in Grade K-8.* Washington,DC: National Academic Press.

Ferguson, Melanie., Brandreth, Marian., Brassington, William & Wharrad, Heather. (2015). *Information Retention and Overload in First Time Hearing Aid Users: An Interactive Multimedia Educational Solution.* United Kingdom: University of Nuttingham.

Fitriana, Sari Ika. (2011). Penggunaan Multimedia Interaktif dalam Proses Pembelajaran Teori Kinetik Gas untuk Meningkatkan Pemahaman Konsep Siswa SMA. *Jurnal Penelitian Pendidikan IPA*, 5(1), 14-20.

Gencer, Savran Ayse & Cakiroglu, Jale. (2005). *Turkish Preservice Science Teacher's Efficacy Beliefs Regarding Science Teaching and Their Beliefs About Classroom Management.* Turkey: Departement of Secondary Science and Mathematics Education. Faculty of Education. Pamukkale University.

Glass, G.V. (1976). *Primary Secondary and Meta Analysis of Research Review of Research in Education.* Retrieved from: http://www.blackwellpublishing.com/medicine/bmj/systreviews/

Hamalik, Oemar. (2011). *Proses Belajar Mengajar.* Jakarta: Bumi Aksara.

Haryanto, I. Nyoman., Marhaeni, Anak Agung Istri Ngurah & Suarni, Ni Ketut. (2015). *Pengaruh Model Pembelajaran Kooperatif Tipe STAD Berbantuan Video Animasi Terhadap Hasil Belajar IPA dan Kreativitas Siswa SMPLB C Negeri Denpasar.* Indonesia: Program Pascasarjana Universitas Pendidikan Ganesha-Singaraja.

Hill, Felix & Korhonen, Anna. (2014). *Learning Abstract Concept Embeddings from Multimodal Data: Since You Probably Can't See What I Mean*. United Kingdom: University of Cambridge.

Huitt, W & Hummel, J. (2003). *Piaget's Theory of Cognitive Development.* Valdosta State University.

International Energy Agency. 2012. *Annual Report*. Retrieved from: http://www.iea.org.

Ivers, K & Baron, A. 2010. *Multimedia Project in Education*. USA.

Jalali, Mohmmad Mojtaba., Masoumi, Ali., Farahani, Nodeh Milad., Hezaveh, Badkoobeh Vahid. (2015). *Evaluating The Role of Digitl Media in The Quality of Training Learning Process of Students.* Bachelor of Education Sciences, Farhangian University, Shahid Bahonar Campus of Arak.

Johnsto, J.L & Moody, S.J. (2013). Motivation to Learn: Mattering From a Multicultural Perspective in School. *Journal Counseling International,* 5(1), 133-140.

Kemdikbud. (2014). *Materi Pelatihan Guru Implementasi Kurikulum 2013. Mata Pelajaran IPA SMP/MTs.* Jakarta: Badan Pengembangan SDM Pendidikan dan Kebudayaan dan Penjaminan Mutu Pendidikan. Kementerian Pendidikan dan Kebudayaan.

Koning, de B.B., Tabbers, Rikers RM & Paas, F. (2009). Attention Guidance in Lerning From a Complex Animation: Seeing is Understanding?. *Learning and Instruction.* 20(2). 111-122. Doi: 10.1016/j.learninstruc.2009.02.10.

Koroghlanian, Carol & Klein, James D. (2000). *The Use of Audio and Animation in Computer Based Instruction.* Arizona State University.

Krause, D.R., Handfield, R.B & Tyler, B.B. (2007). The Relationships Between Supplier Development, Commitment, Social Capital Accumulation and Performance Improvement. *Journal of Operations Management,* 3(2), 15-21.

Liliasari & Tawil, Muh. (2014). *Keterampilan-Keterampilan Sains dan Implementasinya dalam Pembelajaran IPA.* Indonesia: Universitas Negeri

Makasar.

Liu, X. (2006). *Effects of Combined Hands-on Laboratory and Computer Modeling on Student Lerning of Gas Laws: A Quasi Experimental Study.* Journal of Science Education and Technology. Springer.

Magnesen, Vernon A. (1983). *A review of Finding from Learning and Memory Retention Studies.* Published by The National Institute For Staff and Organization Development With Support From The W.K. Kellogg Foundation.

Mahfudz, Asep. (2012). *Cara Cerdas Mendidik yang Menyenagkan.* Bandung: Simbiosa Rekatama Media.

Mayer, E. Richard. (2001). *Multimedia Learnin*g. New York: Cambridge University Press.

----------. (2003). *The Promise of Multimedia Learning: Using The Same Instructional Design Methods Across Different Media.* Santa Barbara. USA: University of California.

Merriyana A, Rosa. (2006). Meta Analisis Penelitian Alternatif Guru. *Jurnal Pendidikan Penabur*, 6(5), 18-22.

Najjar, J. Lawrence. (1998). *Principles of Educational Multimedia User Interface Design.* Georgia: Institute Atlanta.

Naor, Yamit Sharaabi., Kesner, Miri & Shwartz, Yael. (2014). *Enhancing Student's Motivation to Learn Chemistry.* Israel: Welzmann Institute of Science.

National Research Council. (1996). *The National Science Education Standards.* Washington, DC. National Academy Press.

Okoye, Okecha, Nnamdi S & Ebele, Rita. (2008). *The Interaction of Logical Reasoning Ability and Socio-Economic Status on Achievement in Genetics Among Secondary School Student in Nigeria.* College Student Journal.

Organization for Economic Cooperation and Development. (2013). *Snapshot of Performance in Mathematics, Reading and Science*. Retrieved from: http://www.oecd.org/pisa/keyfindings/PISA-2012-results-snapshot-volume I-Eng.Pdf)

Pratiwi, Sarieny. (2011). *Perbandingan* Multimedia dengan Karakteristik yang Berbeda untuk Meningkatkan Penguasaan Konsep Siswa pada Materi Sistem pertahanan Tubuh. *Jurnal Penelitian Pendidikan IPA,* 5(1), 21-28.

Pusat Kurikulum dan Perbukuan Balitbang. (2014). *Buku Guru IPA.* Jakarta: Kemdikbud.

Sardiman, A.M. (2014). *Interaksi dan Motivasi Belajar Mengajar.* Jakarta: Rajawali Press.

Schrader, G. Peter & Eric, E. Rapp. (2015). *Does Multimedia Theory Apply to All Students? The Impact of multimedia Presentations on Science Learning.* Las Vegas. USA: University of Nevada.

Shaffer, DR & Kipp, K. (2010). *Developmental Psychology: Childhood and Adolesence.* Belmont Wadsworth. Cengage Learning.

Siagian, Sahat, Mursid & Wau, Yasaratodo. (2014). *Development of Interactive Multimedia Learning in Learning Instructional Design.* Educational Technology Pos Graduate. Indonesia: State University of Medan.

Somantri, T Sutjihati. (2006). *Psikologi Anak Luar Biasa.* Bandung: Refika Aditama.

Stoney, Sue & Oliver, Run. (1999). *Can Higher Order Thinking and Cognitive Enggement be Enhanced With Multimedia?* Edith Cowan University.

Sungur, s & Tekkaya, C. (2001). The Effect of Gender Differences and Reasoning Ability on The Learning of Human Circulatory System Concepts. *Hacettepe University Egitim Fakultesi Dergisi,* 20(1), 126-130.

Vieyra, Gustavo. (2006). *A Dialectical Interpretation of Factual Knowledge in Vygotskyan Term Vs Bloom's Taxonomy as Interpreted by The Teaching Staff Elementary School.* Los Angeles.

Wang, Jing., Baucom, B. Laura & Shinkareva, Svetiana V. (2012). *Decoding Abstract and Concrete Concept Representations Based on Single Trial FMRI Data.* Columbia: Departement of Psychology, University of South Carolina.

Wiyono, K. (2009). *Penerapan Model Pembelajaran Multimedia Interaktif Untuk Meningkaatkan Penguasaan Konsep, Keterampilan Generik Sains dan Berpikir Kritis Siswa SMA Pada Topik Relativitas Khusus.* Indonesia: Program Studi Pascasarjana UPI Bandung.

Yusuf, L.N & H. Syamsu. (2008). *Psikologi Perkembangan Anak dan Remaja.* Bandung: Remaja Rosda Karya.

Zahra, Binish Syeda. (2015). Effect of Visual 3D Animation in Education. Departement of Computer Science, Lahore Garrison University. *European Journal of Computer Science and Information Technology,* 3(1), 33-43.