

The Development of Physics Learning Instrument Based on Hypermedia and Its Influence on the Student Problem Solving Skill

Bunga Dara Amin^{1*} Alimuddin Mahmud² Muris¹

1. Department of Physics Education, Faculty of MIPA, State University of Makassar, Indonesia

2. Department of Guidance and Counseling, Faculty of Education, State University of Makassar, Indonesia

Abstract

This research aims to produce a learning instrument based on hypermedia which is valid, interesting, practical, and effective as well as to know its influence on the problem based skill of students Mathematical and Science Faculty, Makassar State University. This research is a research and development at (R&D) type. The development procedure was referred to Four-D model consisted of definition phase, design phase, development phase and dissemination phase. The trial test used non-equivalent control group design. The subject of this study was 14 students year 2014/2015 majoring Physics Education as a control class and 30 students of International Class Program (ICP) of Physics Education as an experimental class. The data analysis used Content Validity Ratio (CVR), descriptive analysis, and inferential analysis. The results obtained after applying physics learning instrument based on hypermedia were valid, interesting, practical, and effective assessment. Based on descriptive analysis the average score of ICP class (experimental class) was higher than those of physics education (control class) and the test result based on t-test it was found that there is significantly difference of problem solving skill between control class which used power point with experimental class which used learning instrument based on hypermedia. The results showed that its differences identify the increase of problem solving skill which consists of mapping problems, mathematical skills, numerical skill, space and graph awareness, and estimation skill. Thus, physics learning instrument based on hypermedia can give influence the improvement of problem solving skill of students in FMIPA UNM.

Keywords: learning instrument, hypermedia, problem solving skill

1. Introduction

One of the goals of national education is to educate the nation. If process and outcomes of education are not qualified, the Indonesian people will be impossible to reach the bright, peaceful, and prosperous future. Therefore, the government policy in educational sector should prepare qualified human resource and be able to face the challenges along with changes in every aspect of human life, especially in the globalization era. Educational process must contribute as 'connector-bridge' between individual and the challenge in this rapidly globalization. The preparation process of qualified human resources and adapted to global competitiveness will success if it started from the improvement of learning quality. This is in accordance of the National Education Purpose in 21st century which stated that education in this era is to actualize the national goals, namely a prosperous and respectable society equivalent with other nations (BSNP, 2010). On the other hand, the learning process which are expected to improve the thinking ability, working skill, scientific attitude, communication skill, and scientific attitude as aspect of life skill (BSNP, 2006).

Therefore, to develop thinking skill as a one of the main competency that important to build valuable learning pillars for the sake of education quality. This is in accordance with Bruner's statement (in Sukarjo & Komaruddin, 2009) that the main purpose of learning process is to develop thinking skill. However, student thinking skills in many high school in Indonesia are far behind from the other nations. Effendi's report (2010) based on the result of TIMSS concludes that the average achievement of Indonesia student in term of cognitive aspect (knowing, applying, reasoning) is still low and the trend of achievement always decrease in cognitive aspect. Thus, it must be improved in many aspects, especially in the aspect of reasoning through high order thinking skills.

Moreover, based on the result of initial study on students Physics Education, State University of Makassar, academic year 2012/2013 about concept understanding of quantum physics obtained that the student's ability to translate and interpret an abstract concept to their own language or to table format, graph and mathematics' symbol with numeral's ability is very low (Bungadara, 2014). This indicates that the students' ability to solve physics problems is still low.

The results of the initial study imply that the physics learning has not been able to develop higher thinking skills. This skill in the form of critical and creative thinking as well as problem solving can be achieved through practice. Nickerson, et.al (in Tawil, 2013) pointed out that thinking skills always develop and can be developed. One of the higher order thinking skills is problem solving skill (Pressesein, 1985). The aim of education in school not only to improve knowledge, but also to develop problem solving skill (Wasis D.

Dwiyono, 1999).

According to Mayer & Wittrock (in Adams, 2007) problem solving consists of four characteristics: (i) problem solving as cognitive, (ii) problem solving as process, (iii) problem solving directed to, (iv) problem solving is private or individual. Garofalo & Lester (Kirkley, 2003) stated that problem solving is a process of higher order thinking such as visualization, association, abstraction, manipulation, reasoning, analysis, synthesis, and generalization, each one need to be coordinated. Thinking skill is a complex activities that need knowledge and performance. Knowledge and skill can be trained in short time but competence need longer time and difficult. It can be simplified that problem solving indicator comprise of mapping problem, mathematical skill, numerical skill, spatial-mapping skill, and estimation skill.

The development of science and technology ease communication activity. This can be contributed to the rapid development of Information and communication technology (ICT) which also influence education sector. Information technology can be used to improve learning quality. This is in line with 21st century learning paradigm, which according to R.E Indrajit (2011) and BSNP (2010) stated that: (1) from teacher centered to student centered, (2) one direction to multi directions pattern (interactive), (3) single tool to multi-media based learning, (4) from abstract to real, (5) single simulation to the whole direction, (6) from class based on the user need. Supported by Sagala (2003), learning equipped with an appropriate media not only increases the aspect of doing, understanding, comprehension but also improving motivation compare to using words. According to Budiman (2008) abstracts concepts such as wave particle dualism can be understood by using interactive media. McKagan (2007) pointed out that students understand quantum mechanics concept by means of interactive software.

According to Fabos (2011) the current media is hypermedia as a revolution in learning because hypermedia not only consists of text, graphics, video, and audio, but also provides network to be access by students. Therefore, students can access and use hypermedia by means of laptop, computer, or Tab/Ipad. The use of hypermedia is useful supported by learning instruments such as student book and worksheet. Independently, student can use hypermedia and it's auxiliary without lecturer involvement.

Teaching and learning process through hypermedia system makes student to adapt, supported by improving ideas and concepts of the subjects as well as feedback of their work. Jeanne E.O (2009) stated that hypermedia is an interactive multimedia based on computer providing network structure so that user can adjust their need and processing information individually. Setawan (2007), pointed out that the use of hypermedia in learning magnetic induction improved the mastering of concept and generic skill student. They appreciate the use of hypermedia rather than power-point (Ikhsan, et al, 2003). Hypermedia based on virtual; improve students activity individually as well as in group for modern physics study (Bunga Dara, et.al, 2015).

Based on the aforementioned argument, it is necessary to conduct a research about hypermedia based learning and its instrument which can help students to study individually and active as well as improve their problem solving ability which consists of: problem solving, mathematical ability, numerical skill, spatial-mapping skill, and estimation skill. The hypermedia was developed for quantum physics study ad its influence on the problem solving skill improvement will be observed.

2. Research Method

A. Research Type

This is a research and development (R&D) study on hypermedia and its implementation in classroom. The development was conducted by using 4-D (four D) model developed by Thiagarajam and Semmel (1974). This model consists of 4 stages, namely define, design, develop, and disseminate (Trianto, 2011).

B. Research Design

Two classes were involved in this study, education class by using power point as a control group and International Class Program (ICP) by using hypermedia as an experimental group.

C. Research Subject

Research subject was physics education student taking introduction to quantum physics course, academic year 2014/205 at Science Faculty UNM, which comprise of 14 students at education class and 30 students at ICP class.

D. Research Instrument

Instruments used in this study were questionnaire of media expert, subject expert, student's activity, student's perception and problem solving skill.

E. Data Analysis

Data from experts was analyzed, coded, and described qualitatively and continuing in order to have evaluation category. The validity content was determined by using Content Validity Ratio (CVR) and Content Validity Index (CVI). The instrument was valid if the CVR and CVI are at the scale 0 to 1, as follows:

$$CVR = (n_e - (N/2)) / (N/2)$$

Where:

- n_e : the number of validators that provide essential values (good or excellent)
- N : the number of validators validity every aspect, CVI by using the following equation,

$$CVI = CVR / \sum n$$

Where:

- n : the number of items from every aspect
- If the statement is valid, reliability analysis followed using the following equation,
- $$r_{11} = (k / (k-1)) \cdot (1 - (\sum \sigma_b^2 / \sum \sigma_t^2))$$

Where:

- r_{11} : reliability of the instrument
- k : the number of questions
- $\sum \sigma_b^2$: the amount of the question variance
- $\sum \sigma_t^2$: total variance

The reliability value was consulted with reliability table. The instrument is reliable if calculated reliability is higher than the reliability table. To analyze the influence of learning by hypermedia to problem solving skill, inferential analysis were used which consists of normality-test (Kolmogorov-Sminov), Homogeneity-test (Levine Test), and hypothesis test (T-test).

3. Results and Discussions

A. Hypermedia

Software used in developing hypermedia was Flash Decompiler to adapt and develop Physics Simulation downloaded from the King's Center for Visualization in Science (KVCS) (<http://www.kvcs.ca>). The main software used was Lector to adjust the media program appearance. The development of this media can solve student's problem easily. In learning process, there were hosting used was fisikakuantum.host.56.com. The prospect consists of the subject, pictures, animation, and interactive simulation. The initial appearance of this hypermedia is as follows:

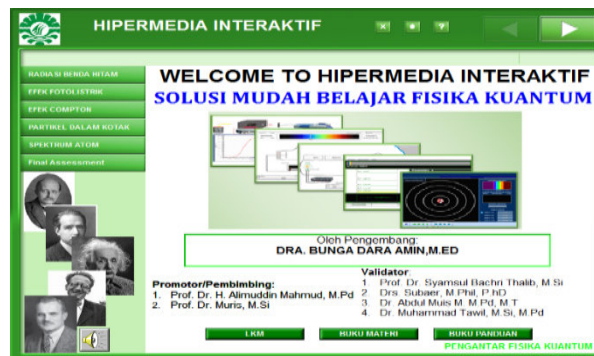


Figure 1. Initial appearance

Student can download the book, handbook and worksheet. The media was equipped with audio to directed students on how to use it. It is also contain soft music to make student enjoy the learning process.

Figure 2 shows the page of Blackbody radiation experiment.

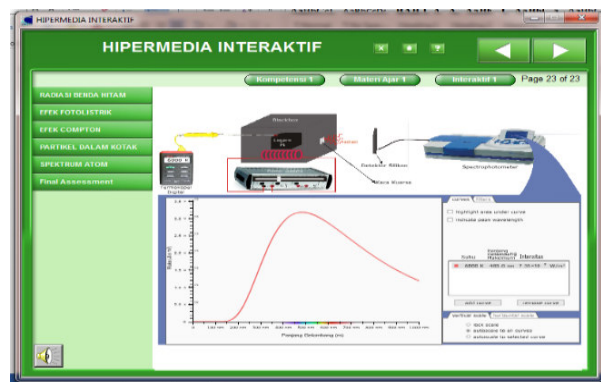


Figure 2. Blackbody radiation

Figure 3 shows the Photoelectric Effect.

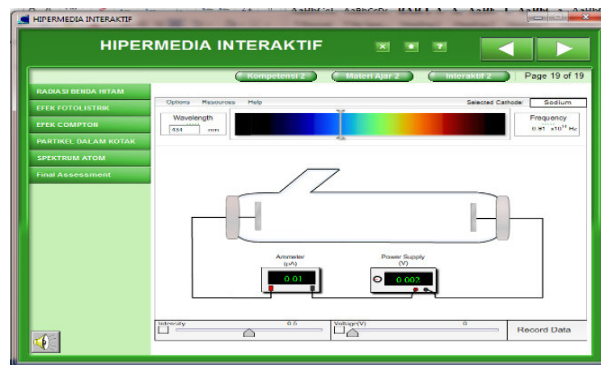


Figure 3. Photoelectric Effect.

Figure 4 shows Compton Effect.

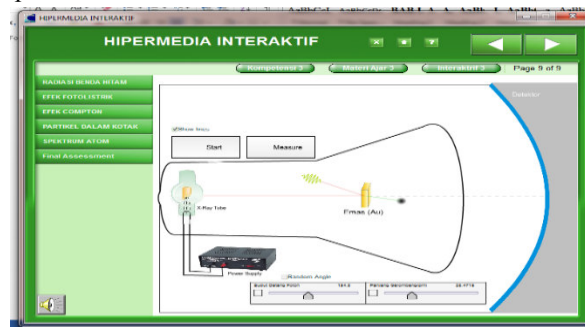


Figure 4. Compton Effect

Figure 5 shows Particle in a box.

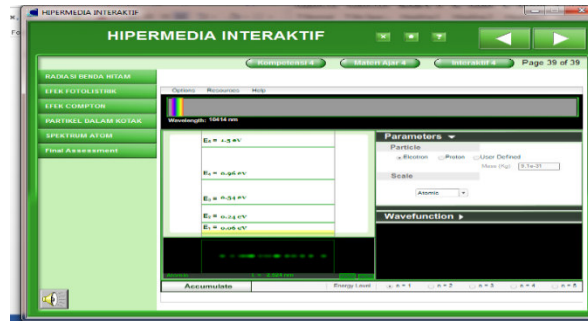


Figure 5. Particle in a box

Figure 6 shows the Atomic Spectrum Experiment

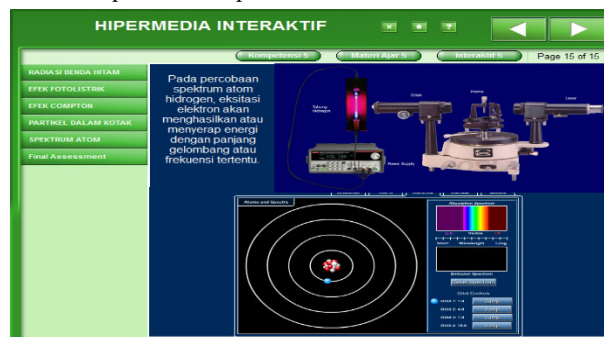


Figure 6. Atomic spectrum experiment

B. Hypermedia Evaluation Media

Hypermedia evaluation was conducted by content and media experts. The result of validation analysis shows that hypermedia was valid and reliable for all aspects are shown on the following table.

Table 1. Analysis result of validation

No.	Aspects	Percentage (%)
1	Display Quality	91.25
2	Attraction	94.44
3	Technical	90.00
	Average	92.19

The validation result shows that the subject (content) in hypermedia was valid and reliable.

Table 2. Analysis result of content validation

No.	Aspects	Percentage (%)
1	Material/concepts	95.85
2	Linguistics	93.80
3	Presentation	95.31

The student worksheet result is shown in Table 3.

Table 3. Analysis result of worksheet

No.	Aspects	Percentage (%)
1	Material/concepts	95.83
2	Linguistics	93.80
3	Presentation	91.70

The handbook results in shown in Table 4.

Table 4. Analysis result of handbook

No.	Aspects	Percentage (%)
1	Material/concepts	97.00
2	Linguistics	93.80
3	Presentation	91.70

C. Student's Activity

The diagram about student's activity is shown as follows:

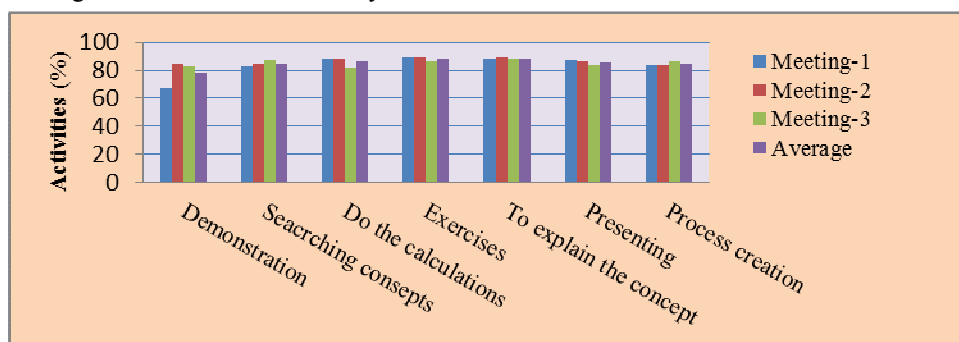


Figure 7 Student's activity

Based on the observed evaluation on each meeting it was found that students activity was above 80%. This indicates that learning by using hypermedia give student's opportunity to work. It gives students to explore instead of listen and take note as pointed out by Cengiz (2010) that media equipped with learning instruments engaging students to be active.

Research conducted by Irfan (2012) also measured the activity and perception of students. The advantage of hypermedia is web based so that students can access it independently, whenever and wherever they want to.

The research results do not imply that virtual laboratory is more effective than real laboratories. The simulation is conducted to overcome the equipment shortage, time consideration and abstraction of the subject.

D. Students Perception

Data about student's perception in the learning by using hypermedia is as follows:

Table 5. Student Perception

No	Indicator	Percentage (%)
1	Facilities of learning instrument based on hypermedia	90,33
2	The attraction of learning by using instrument based on hypermedia	92,35
3	Learning activities by using instrument based on hypermedia	91,84
Average		91,03

Based on students evaluation on the learning using hypermedia it was found that student perception was above 90% agreed on the use of hypermedia. None of them disagree with the implementation of hypermedia in learning. Students were interested on the hypermedia appearance, easy to run, the content easy to understand and enjoy learning with hypermedia. This is in accordance with Yulianti et.all (2012) who found that hypermedia based learning are able to improve the affective competence which includes feeling, interest, and attitude towards learning process.

E. Students Competence in Problem Solving

The average score of class used hypermedia and power point in Physics learning is pictured in Figure 8.

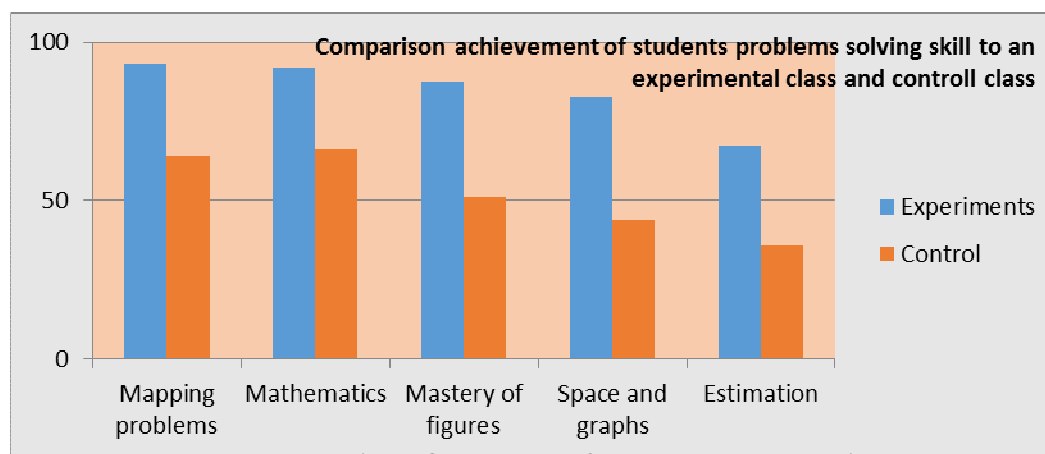


Figure 8. The score of students problem solving

Figure 8 shows that the use of hypermedia was able to improve student's competence in solving problems.

4. Conclusion

- The learning tools based on hypermedia are in category:
 - Valid and reliable which motivate students to participate in learning process.
 - Interesting which invite students to do virtual simulation.
 - Practical which provides student's need for understand the problems and themes.
- The hypermedia was in category effective resulted in mastery learning of 83, 86% and positive response of 91, 30%.
- There is a significant differences of the ability of solving problems between students taught using power point and those taught using hypermedia in terms of mapping problems, mathematical skill, numerical skill, space-mapping skills, and estimation skill.

References

- Fabos, D (2001). *Media in the Classroom An Alternative History*. Paper Presented at the annual Conference of the American Educators Research Association, scattle, WA. (ERIC Document Reproduction Service No ED 454 850).
- Fahy, Patrick J. (2003). *Planning for Multimedia Learning* Dalam Sanjaya Mishra dan Ramesh C. Sharma, *Interactive Mutimedia in Education and Training*, London: Ideaa Group Publishing.
- Finkelstein,N. Wendy Adams (2006). *Interactive Simulation for Teaching and Learning Physics*. Jurnal The Physics Teacher. Volume 44 Januari 2006.
- José Chamoso Sánchez, Luis H. Encinas, Mercedes R.S. Ricardo L.F (2002). *Designing Hypermedia tools for Solving Problem in Mathematics*. Journal Computer & Education 38.(2002) 303-317.
- Kaya.D.D Izgiol dan C.Kesan (2014). *Investigation ofm Elementry Mathematies Teacher Candidates, Problem Solving Skill. According to Various Variable*. Internasional Journal of Elementry Educational 6(2) 295-314.
- McKagan, S.B., K.K. Perkins,M. Dubson,C. Malley, S. Reid,R. LeMaster., C.E. Wieman. (2008). *Developing and Researching PhET Simulation for Teaching Quantum Mechanics*. Physics Education Technologi

Journal.

- McKagan, S.B, K.K. Perkins, and C.E. Wieman (2007). *Deeper look at student learning of Quantum Mechanics: The case of tunneling*. The American Physical Society Journal.
- Nieveen, Neike. (1999). *Prototyping to Reach Product Quality*. Nieveen, & Tj. Plomp, K. Gustafson, K; Branch, RM dan In Jan Van den Akher. *Design Approaches and Tolls in Education and Training*. Dordrecht, The Netherlands: Kluwer Academic Publisher.
- N.J. Mourtos, N. DeJong Okamoto & J. Rhee. (2004). *Defining, Teaching, and Assessing Problem Solving Skills*. 7th UICEE Annual Conference on Engineering Education. Mumbai India, 2004.
- Reddi, Usha V. dan Sanjaya (2003) : *Multimedia as An Educational Tool*: New Delhi, Commonwealth Educational Media Centre for Asia.
- Setiawan, A. dkk. (2007). *Influence of Hypermedia Instruction Model on Magnetic Induction Topic to Comprehension of Physics Concept and Science Generic Skill of Physics Teachers, Proceeding of The First International Seminar on Science Education*. SPS UPI Bandung.
- Steinberg, R.N, Oberem G.E, McDermott, L.C. (1996). *Development of a computer-based tutorial on the photoelectric effect*, Am. J. Phys. 64, 1370-1379.
- Tatli & A. Ayas. Z. (2012). *Virtual Chemistry Laboratory Effect of Constructivist Learning Environment*. Turkish Online Journal of Distance Education, Vol 13, no 1, 183-199..
- Wendy K. Adams. (2007). *Development of a Problem Solving Evaluation Instrument; Untangling Of Specific Problem Solving Skills*. Dissertation, 2007.
- Yuen- Kuang Cliff. Liao. (1999). *Effects Of Hypermedia On Students' Achievement: A Meta-Analysis*. Journal of Educational Multimedia And Hypermedia, 8(3) 255-277.