e-ISSN: 2548-4613

THE APPLICATION OF MATHEMATICS VISUALIZATION MEDIA ON THE COMPETENCE OF GENERAL PHYSICS

Muhammad Nuh[1*]
[1]Faculty of Science and Technology, UIN Sumatera Utara, Medan, Indonesia
*Corresponding author: emnoeh@gmail.com

Abstract- difficulties of students in mastering the competence of general physics in the faculty of science and technology (fst) *uin sumatera utara* is to understand the application of the principle of physics that use mathematics in discussing the exercises of problem solving. The lack of face to face time does not necessarily limit the process of the exercise. Lecturer can facilitate independent learning for students to apply a computer-aided mathematics visualization media. The purpose of research is to describes the results of the application of mathematics visualization media that focus on students' attitudes toward independent learning computer-aided mathematics visualization media and its influence on the achievements of motion dynamics. The application of mathematics visualization media using the methods of research and development. The design of this media development model of software development through five phases: requirements analysis, design media, media development, implementation, and testing. This study empirically shows first, a mathematics visualization media designed according to criteria of good based media expert assessment of learning as measured by the dimension of visual elements, text elements, and attractiveness the average of 2.33 or 78% fit for use for independent learning for students. Second, the attitude of students toward mathematic visualization media used to support independent learning for students according to criteria of medium shown with an average score of 2.25 or by 75%. Third, the achievements of motion dynamics shows phase to an average of 64.34 (or 78%).

***Keywords*:** mathematics visualization media, and the compentence of general physics

1 INTRODUCTION

General physics or Basic physics is one of the subjects fundamental on a degree program in the faculty of science and technology at a university, especially in the course of mathematics and natural sciences (MNS). This course covers aspects of the theory and practice given in the first year in the first semester (basic physics 1) and second semester (basic physics 2), but in the course of non physical the number of semester credit system can be different from that 2 semester credits with lecture material that is compacted or selected. The general physics course included subjects with basic math prerequisite is standard with a strong base, knowledge of vectors and analysis. It turns out that the standard basic mathematical skills alone are not enough for the students of MNS to master the competence of general physics is well. Laboratory experiments support activities encourage students understand abstract things of the concepts and principles of physics. Another capability that must be trained is the understanding of the students in making a sketch or free body diagram is an effort that must inevitably controlled properly.

The quiz score and the final exam scores of this subject is still not reach the standard of assessment so that students get an average grade of B (standard letter grades) with a repetition rate in the quiz is quite high. It is caused by a lack of understanding of the students because the material on a physics course are largely abstract and load equation math is quite difficult as the time allocated only 2 semester credit system to discuss the theory, 1 credit for the work in the laboratory. Learning to do this time is still limited to the explanation of abstract concepts through a expository strategy aided whiteboard and static presentation media. Consequently, many students who have difficulty in understanding the concepts and principles of physics. The involvement of student responsibility in lectures infinitesimal because activity teachers predominate. Several times was forced to the lecture theory can not be resolved properly considering the limited time available such a situation should the effort to shift the ways lectures applying a strategy that involves the activity of students in mastering the course well.

This mini research study describes how to find a solution a issues common to the general physics lecture for students majoring in non-physics, namely through the development of instructional media which give responsibility to the students to be active and creative to find, manage, and use information

to achieve the competence of general physics. In addition to improving learning outcomes physics student learning media application can also develop positive attitudes of students towards the courses. Other efforts of the lecturer is to simplify the way that students understand the concepts and principles of physics with the help of media that lead to independent learning. When considering forms of difficulties experienced by students in learning the general physics, the characteristics of a good learning media is able to motivate students to independent learning and be able to direct mathematical visualization process step by step in accordance with the concepts and principles of physics. It therefore applied the mathematical visualization media on the competence of general physics at the Faculty of Science and Technology (FST) State Islamic University (*Universitas Islam Negeri, UIN*) *Sumatera Utara*, particularly for non-physics majors at *Dinamika Gerak Lurus* course materials. This lecture has been held on a student of mathematics at FST *UIN Sumatera Utara* Academic Year 2016/2017 first semester.

2. THEORY

2.1. Mathematics Visualization Media In Physics Lectures

See a visualization does not automatically guarantee that a student will learn from it. The student should be guided towards deciphering (decoding) the right visual. One aspect of visual literacy is the ability to interpret and make meaning of stimuli [1]. The research-based theories tend to discuss some variables that affect how a student decipher the meaning of visual. The variables include the effects of development, cultural effects, and visual preferences [2]. Another variable that also influences the way students decipher visual meaning is the attitude of the students in learning. Attitude as the tendency of action will give directions to the deeds or actions. But this does not mean that all actions or deeds someone synonymous with the attitude that there is to it. The attitude as the degree of affect positive and affects negatively to an object psychologically. The object of psychological question is symbols, phrase, motto, people, institutions, professions, and ideas that can be divided into positive or negative feelings [3]. So theoretically the attitude of students to mathematical visualization media can affect the way students in breaking visual meaning.

2.2. The Competenceis of General Physics

The competencies of general physics or the basic physics is course in the graduate program in FST UIN *Sumatera Utara* that were mandatory for the first-year student in the faculty. Study the general physics to the physics department includes complete material in two semesters while majoring non-physics material that compacted for one semester at one year. The topics of general physics which contains complete material consists of topics as follows: Measurement, Kinematics and Dynamics of Motion, Circular Motion, Work and Energy, Linear Momentum, Motion Rotation, Rigid Body Rotation, Fluid, Vibrations and Waves, Sound, Temperature and Heat, Laws of Thermodynamics all these topics are discussed in first semester [4]. Furthermore, complete material covered in the second semester include: Electric Charge and Electric Field, Electric Potential, Electric Current, Circuit DC, Magnetism, Electromagnetic Induction, Electromagnetic Waves, Light, Nature Wave of Light, Tools Optical, and The Theory of Relativity [5]. Comparison of the topics in the general physics for the material compacted in one semester include: Measurement, Kinematics and Dynamics of Motion of One and Two Dimensional, Rigid Body Rotation, Fluid, Vibration and Waves, Temperature and Heat, Thermodynamics, Electricity and Magnetism, Geometrical Optics and Modern Physics [6].

The Competencies of general physics is the fundamental physics of material selected the undergraduate program in the FST for non-physics majors. The Competencies of general physics specially emphasized on the course objectives, namely: (a) explain the basic concepts of physics and between concepts within the contextual issues, (b) apply the principles and procedures of physics into a mathematical model for solving routine problems and engineering, and (c) analyzing the concepts, principles and procedures for the determination physics problem solution. To achieve the competencies general physics are many factors that affect the process and student results. Factors that affect the process and outcome of learning physics at FST *UIN Sumatera Utara* based on observations and interviews can be explained as follows: (a) intake of students who graduated in the selection entrance exam *UIN Sumatera Utara* showed their varied backgrounds, (b) the ability of prerequisite knowledge of mathematics for the competence of general physics is inadequate, (c) the lecture

centered on the activities of teaching and expository, (d) a source of student learning is still limited, and (e) facilities supporting laboratory activities are still minimal. Factors that affect the process and the achievement competence of general physics should be managed by considering the analysis of the task and the need lectures. One effort to encourage students to achieve these outcomes is to facilitate learning by developing learning resources and strengthening the knowledge a prerequisite for competence of general physics.

The development of learning resources that have been made to facilitate student learning is the development of teaching materials that encourage independent learning ability is the procurement of e-books and mathematics visualization media. Procurement of e-book gives students the opportunity to fill the initial knowledge so that they have the readiness to learn. Knowledge early starts of the task to examine reading material from e-book that has the forms of learning such dun resumes. The best hope is a resume deliberately produced by the students individually using common media presentations. They should send a resume to the email long before the topic was studied in the activity time face to face. Efforts to maximize theory class (face to face lectures) with the time allocation of 2 semester credit system would be a strategic move to increase students' motivation and their learning readiness. This effort is part of a strategy to shift from tradition of lectures centered on teachers to tradition of lectures centered on student. Of course this eventually changed the way students learn than just passively receive knowledge be actively generating knowledge from a variety of learning resources available.

The competencies of general physics requires learning ability of students who are skilled in mastering the concepts, principles and procedures of physics well. The allocation of lecture time only with 2 credits would not do much to improve the learning ability of students, especially practice by improving the ability of reasoning and problem resolution in accordance with the structure of the tasks in the competenceis of general physics. When reasoning and problem solving should be trained in such a way with time face to face relatively short, the self-learning ability of students to be the important factors that support their success in achieving the competencies of general physics. One of the competencies of general physical is to use mathematics as a tool for communicating physics, especially in developing reasoning on principles and procedures of physics.

2.3. The Nature of Mathematics Visualization Media

Instructional media has an important role in the learning process. The use of instructional media can assist lecturer in delivering the course material. Learning success is determined by two main components of teaching methods and instructional Media. Both of these components are complementary in maximizing achievement of competencies or learning outcomes. Selection of a particular method will be associated with the instructional media. In general physics lectures, students are often faced with matters are complex, abstract and meta empirical elusive. Such material is often encountered in discussing the application of the concepts and principles of physics such as drawing a sketch to simplify the physics in the form of "free body diagram". Free body diagram is the students' ability to describe the magnitudes of physics graphics into vector and identify with the symbols of mathematics relationships magnitude so as to facilitate the process of analyzing physical quantities in accordance with the principles and physics formulas mathematically.

To assist students in understanding the process of drawing free body diagrams are traditionally lecturer uses a blackboard or whiteboard to give or to review examples of problems. At the time of the review are many examples in fact blackboard capacity is limited. To overcome this, lecturer uses visual media is projected to slide like media presentation. Visual media in the form of Figures, charts, diagrams with no animations can be created using a variety of computer application programs. The most commonly used is powerpoint based on Microsoft Office that are well suited for making presentations and instructional materials for all levels of education [7]. Powerpoint presentation media also makes it possible to overcome the weaknesses of blackboard in the review examples of physics problems. Repeat with the right of each process and the steps for setting free diagram objects do not allow the blackboard but through the application of mathematics visualization media makes the process easier to repeat according to the students' learning pace. Figure 1 is an example showing a series of visually describe the process diagram objects freely to the process of lowering the mathematical equation. Media were able to describe the process of generating mathematical equations through the concepts, principles and procedures visually physics called the mathematics visualization media.

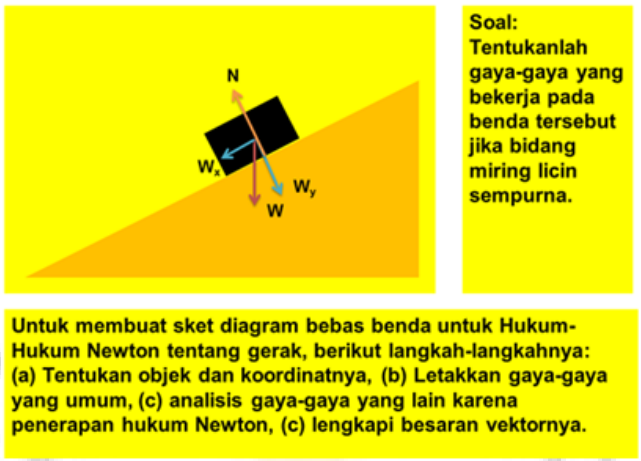

Figure 1 Appearances of Mathematics Visualization Media

Based on the understanding of mathematical visualization media is visible excess media in the order and repetition to support the process of appreciation of the student experience in understanding the laws of physics. Besides visualization characteristics to be attractive with attention to the layout and colors that help a surprise for the eye to follow the sequence of processes in the media. Visual can play many roles in the learning process, namely: (a) providing a reference concrete for the idea, (b) make abstract ideas into concrete, (c) to motivate the students, (d) directing attention, (e) repeating the information in different formats, (f) recalls the previous learning, (g) reducing the effort to learn [8]. The phrase "reducing the effort to learn" this means that the barriers to learning can be reduced as the ease of students in breaking visual meaning of the course material. The advantages of mathematics visualization is an interpretive media that is able to describe the relationship of theoretical or abstract. Visual interpretive helps students build a mental model of an event or process that is invisible, abstract, or both [9]. Visual design guide generally follow three essential parts of a visual-based media, namely: (a) visual elements consisting of the preparation, balance, color, and legibility; (b) The elements that consist of text style, size, spacing, color, and capitalization; and than (c) the appeal that includes a surprise, texture, and interaction.

2.4. The Students' Attitude Towards Mathematics Visualization Media

Rating scale of attitude starts from the understanding attitude which is the level of affection that is positive or negative is associated with psychological object [10]. This formula shows that can be interpreted positively happy while negative means not happy or reject. To find such an attitude that we need the observation using a specific value. Scale is a measurement tool that provides assignment of symbols to certain rules. For example, to measure student attitudes toward mathematics visualization media are expected to use the gauge student response enclosed a questionnaire that asks results of the implementation of the media can be described clearly. One scale to complement it is a Likert Scale. Likert Scale contains grains approximately equal in attitude or weight value. Subjects responded with varying degrees of intensity based on a range of scales between the two polar opposites.

The questionnaire used in the range of categories of good, average, and less. Special to the questionnaire students' attitude towards the media covers questions relating to four issues: (a) the benefit of the media in supporting the presentation of teaching, (b) display media in facilitating the students to use their own, (c) interaction of the media is able to direct users to follow navigation and order learning, and (d) self-learning increase the capacity of media in demanding learning beyond face-to-face.

Relevant Research

The results of previous studies that are relevant to the development and utilization of mathematics visualization media can be mentioned among others:

The results of the study Helena Evadonna Siagian, Nurdin Bukit and Derlina entitled "Effects Model Inquiry Training Using Macromedia Flash and Thinking Skills Creative toward Skills Process Science" shows that the learning model inquiry training using Macromedia Flash is better than the

conventional learning in enhancing science process skills of students, skills process science group students with high creative thinking skills better than in the group of students with creative thinking ability is low, and there is interaction between the learning model training inquiry using macromedia flash with the ability to think creatively to influence students' science process skills [11].

Results of research Darius J Padang and Sehat Simatupang entitled "Influence Learning Model Based on Problem Assisted Animation Macromedia Flash toward Students' achievement at Electric Dynamic" indicates that there is an influence due to the learning model based on problem-assisted animation Macromedia Flash to the students' achievement in the material Electric Dynamic in Class X *SMAN 1 Tanjung Morawa* in *Tahun Pelajaran* 2013/2014 [12].

3 METHODS

Development of instructional media general physics course includes methods of research and development. Design and development of media using the model of software development through the 5 stages which include: (a) analysis of needs, (b) design, (c) the development of media, (d) the application or implementation, and (e) testing or evaluation as shown in Figure 2.

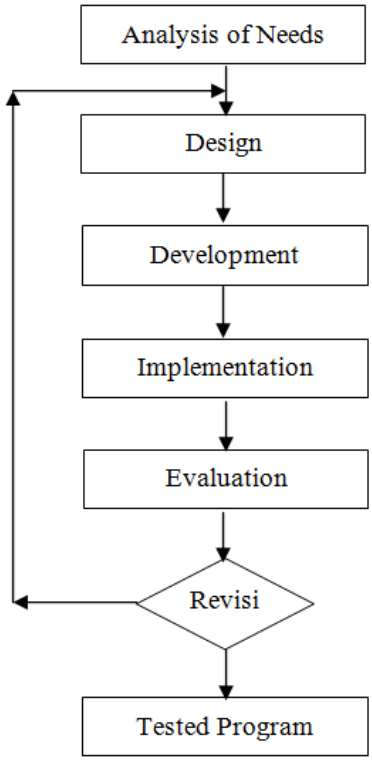

Figure 2 Stages of Media Development

Methods of data collection conducted using questionnaires and generate descriptive data as follows: (1) In connection with the dimensions of visual elements, text elements, and the attractiveness of the media is done through a review by media experts, instructional design experts, as well as subject matter experts. Media experts see aspects of technical standards of quality media. Instructional design experts viewed the sequence of events of learning and task analysis contained in the application process the media. Subject matter experts view the content or the content of teaching materials that must conform to the science that is inserted in the media element. And (2) Measuring the quality of media that has been developed should get a response from the user that is teachers and students. To get a response that indicates the quality of the media is done by questionnaire implementation of mathematics visualization media in lectures of general physics, especially the material Straight Motion Dynamics.

In the process of testing or validation of learning media developed in small groups used a questionnaire with likert scale. Scores obtained from the questionnaire is then determined average value. For the purposes of qualitative analysis, each of the answers obtained were scored as either category (value 3), the medium category (value 2), and less category (value 1).

4. RESULTS AND DISCUSSION

4.1. Validation Expert of Learning Media

Validation by expert instructional media through the mechanism provides results of the development of instructional media that is so in the form of CD (compact disk) and media experts provide an assessment of the media d natural shape of your checklist in the form of a questionnaire. The number of experts from mathematics visualization media consists of 3 people who have represented, that is: (a) expert practitioners of mathematics visualization media, (b) experts or practitioners of instructional design, and (c) teaching materials expert especially in the subject of physics. List checklist questionnaire containing three-dimensional visual assessment adapted from Smaldino, Lowther and Russell [13].

Table 1 Assessment of Instructional Media Expert

Dimensions of Development Media	Item Number	Average Score	Percentage
Visual Elements	12	2.25	75%
Text Elements	15	2.40	80%
Attractiveness	9	2.33	78%
Total	36	2.33	78%

Table 1 shows that the percentage score dimensional visual elements provided by validator is 75%. For the dimension text elements in the judgment of the validator is 80% while for dimensional appeal validator ratings by 78%. Based on the percentage score Likert scale media development dimension of visual elements, text elements, and the appeal of media are respectively 75%, 80% and 78% respectively categorized as moderate, good and moderate.

4.2. The Results Trial on Student

The results of the validation phase of the learning media experts have been described. Next up is the result of the trial phase instructional media in students and lecturers, that is instructional media users to apply them in the lecture. The lecturer of general physics course are simulated using mathematics visualization media and they asked for a description of the feasibility and mathematics visualization media standards. After that, the lecturers went on simulations or use of instructional media in front of the class. Students try and apply themselves, especially when they need information deepening of the material to be repeated outside the lecture theory (face to face).

Once students see and use instructional media is then carried out measurement of the response of the students on the benefits and functions of mathematics visualization media at Straight Motion Dynamics material. Student response to media recorded based on the contents list of the checklist on the questionnaire. Data from questionnaires filled in mean score of students obtained results that showed interest in students to use these media and media states mathematics visualization useful to help them in independent learning.

Table 2 shows that the percentage score students' attitude towards the mathematics visualization media based questionnaire showed 75% of students expressed the attitude towards the benefit of the media, including the medium category. Furthermore, 80% of the students stated attitude toward the media to see either category. While the students' attitude towards media interaction 70% medium category, and 75% of student attitudes towards the role of the media in supporting independent learning medium category. In general, the attitude of students to visualize mathematics media used to support independent study meet the criteria of being shown with an average score of 2.25 or by 75%. These results are also supported by tests that show learning outcomes general physics in straight motion dynamics material shows phase to an average of 64.34 (or 78%).

Tabel 2 Students' Value Response toward Mathematics Visualization Media

Dimensions of Media Development	Item number	Average Score	Percentage
Expediency	8	2.25	75%
Display	13	2.40	80%

Interaction	6	2.10	70%
Independent learning	4	2.20	74%
Total	31	2.25	75%

5. CONCLUSIONS

In accordance with the purpose of research and discussion results conclusions can be stated as follows: (1) a mathematics visualization media designed to meet both criteria based media expert assessment of learning as measured by the dimension of visual elements, text elements, and appeal to the average of 2.33 or 78% fit for use for independent learning; (2) the attitude of students to mathematics visualization media used to support independent learning meet the criteria of being shown with an average score of 2.25 or by 75%; and (3) the learning outcomes of general physics in straight motion dynamics material shows phase to an average of 64.34 (or 78%).

REFERENCES

[1] Sharon E. Smaldino, Deborah L. Lowther and James D. Russell, *Instructional Technology & Media for Learning*: *Teknologi Pembelajaran dan Media untuk Belajar*, Edisi Kesembilan, Alih Bahasa: Arif Rahman, Jakarta, Kencana, 2011, pp. 69.

[2] Sharon E. Smaldino, Deborah L. Lowther and James D. Russell, *Instructional Technology & Media for Learning*: *Teknologi Pembelajaran dan Media untuk Belajar*, Edisi Kesembilan, Alih Bahasa: Arif Rahman, Jakarta, Kencana, 2011.

[3] Saifuddin Azwar, *Sikap Manusia, Teori dan Pengukurannya*, Yogyakarta, Liberty, 1995.

[4] Douglas C. Giancoli, *Fisika: Prinsip dan Aplikasi*, Edisi ketujuh Jilid 1, Alih bahasa: Irzam Hardiansyah, Jakarta, Erlangga, 2014.

[5] Douglas C. Giancoli, *Fisika: Prinsip dan Aplikasi*, Edisi ketujuh Jilid 2, Alih bahasa: Irzam Hardiansyah, Jakarta, Erlangga, 2014.

[6] Linda Huetinck and Scott Adams, *Cliffs Quick Review™ Physics*, New York, Hungry Minds, 2001.

[7] Rayandra Asyhar, *Kreatif Mengembangkan Media Pembelajaran*, Jakarta, Referensi, 2012, pp. 68.

[8] Sharon E. Smaldino, Deborah L. Lowther and James D. Russell, *Instructional Technology & Media for Learning*: *Teknologi Pembelajaran dan Media untuk Belajar*, Edisi Kesembilan, Alih Bahasa: Arif Rahman, Jakarta, Kencana, 2011.

[9] Sharon E. Smaldino, Deborah L. Lowther and James D. Russell, *Instructional Technology & Media for Learning*: *Teknologi Pembelajaran dan Media untuk Belajar*, Edisi Kesembilan, Alih Bahasa: Arif Rahman, Jakarta, Kencana, 2011, pp. 78.

[10] Omar Hamalik, *Psikologi Belajar dan Mengajar*, Bandung, Sinar Baru, 2000, pp. 214.

[11] Helena Evadonna Siagian, Nurdin Bukit dan Derlina, "Efek Model *Inquiry Training* Menggunakan *Macromedia Flash* dan Kemampuan Berpikir Kreatif terhadap Keterampilan Proses Sains", *OJS Inovasi Pembelajaran Fisika (INFAPI)*, vol.3, no. 2, 2015, pp. 18 - 25.

[12] Darius J Padang dan Sehat Simatupang, "Pengaruh Model Pembelajaran Berdasarkan Masalah Berbantu Animasi *Macromedia Flash* Terhadap Hasil Belajar Siswa Pada Materi Listrik Dinamis", *OJS Jurnal Pendidikan Fisika*, vol. 5, no. 1, 2016, pp. 9 - 18.

[13] Sharon E. Smaldino, Deborah L. Lowther and James D. Russell, *Instructional Technology & Media for Learning*: *Teknologi Pembelajaran dan Media untuk Belajar*, Edisi Kesembilan, Alih Bahasa: Arif Rahman, Jakarta, Kencana, 2011, pp. 91.