CHARACTERISTIC OF MECHANICS TEACHING MATERIALS FOR INCREASING STUDENTS OF PHYSICS TEACHER CANDIDATES REPRESENTATION ABILITY ON VERBAL, MATHEMATICAL, PICTURE, AND GRAPHIC

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ABSTRAK

Penelitian ini adalah tentang karakteristik pengajaran mekanik untuk meningkatkan kemampuan representasi mahasiswa calon guru fisika pada verbal, matematika, gambar, dan grafis. Masalah penelitian adalah bagaimana karakteristik bahan ajar mekanik dapat membantu mahasiswa calon guru fisika dalam meningkatkan kemampuan representasi mereka pada verbal, matematika, gambar, dan grafis. Masalah penelitian ini diterjemahkan ke dalam dua pertanyaan. Pertama, bagaimana bahan ajar mekanik terdiri dari contoh aplikasi prinsip mekanika dalam gambar peristiwa fisika? Kedua, bagaimana pola penulisan bahan ajar mekanik bagi mahasiswa calon guru fisika? Penelitian ini merupakan pengembangan bahan ajar mekanika, menggunakan metode campuran model investigasi, yaitu: pengumpulan data kualitatif, membangun pengajaran mekanik, rancangan materi sehingga akan siap untuk divalidasi. Subjek penelitian diharapkan mampu meningkatkan kemampuan representasi pada verbal, matematika, gambar, dan grafis. Responden penelitian ini adalah mahasiswa fisika calon guru yang mengambil subjek fisika dasar fakultas keguruan dan pendidikan, Universitas Jember. Adapun teknik pengumpulan data adalah: observasi, angket, tes dan dokumentasi. Data dijabarkan secara kualitatif. Hasil penelitian menunjukkan bahwa bahan ajar mekanik terdiri dari contoh aplikasi prinsip mekanika dalam gambar acara fisika dan memiliki pola urutan bab, judul sub bab, deskripsi materi, contoh, uji kemampuan dan bibliografi.

Kata Kunci: bahan pengajaran mekanik, calon guru fisika, kemampuan representasi pada verbal, matematika, gambar, dan grafik

ABSTRACT

This research is about characteristic of mechanics teaching for increasing students of physics teacher candidates representation ability on verbal, mathematical, picture, and graphic. Research problem is about how the characteristic of mechanics teaching materials can help students of physics teacher candidates increasing their representation ability on verbal, mathematical, picture, and graphic. This research problem translated into two questions. First, how is the mechanical teaching materials consists of examples of mechanics principle application in physics event pictures. Second, how is the pattern of writing mechanical teaching materials for students of physics teacher candidates. This research is the development of mechanics teaching materials, using mix methods investigation model, those are: collecting qualitative data, building mechanical teaching, material draft so it will ready for validating. Research subject on this mechanical teaching materials are hopely able to increase students' representation ability on verbal, mathematcal, picture, and graphic. The respondent of this research are students' physics teacher candidates that taking basic physic subject in faculty of teacher training and education, Jember university. The technic of collecting data are observation, questionnaire, test and documentation. The data were qualitatively described. The research result shows that mechanical teaching materials' consist of examples of mechanics principle application in physics event pictures and having written pattern that are title sequence chapters, title sub chapters, material description, example of test, test of ability and bibliography.

Keywords: mechanical teaching materials, physics teacher candidates, representation ability on verbal, mathematical, picture, and graphic

INTRODUCTION

The quality the implementation of education through learning physics cognitively is regarded good, when, after teaching students have a level of complex thought of about high physics, on this way could be concluded that students' creativity thought and student critically thought are also high (Nickerson, Perkins, & Smith, 1985). A not good teaching implementation are caused by: (1) curriculum or component is not good (Sudjana, 1991, Fattah, 2000); competence (professionalism) of the teachers is not enough (Fattah, 2000); and (3) students ability in learning physics are low (Dahar, 1989).

Good curriculum also contained of evalution component, that is containing methods of doing measurement about acquiring the implementation of teaching (Zais, 1976; Nasution,1991, BSNP, 2006) where as character of students that block physics teaching, such as: (1) being not talented in studying physics (Dahar, 1989); and (2) motivation of studying physics is low (Dahar, 1989, Sudjana, 1991, Dimmiyati & Mudjiono, 1999)

National science education standart said that method of teaching will be sucessful if it is explained with a real example of how to use teaching methods for teaching physics subject in right context (NRC, 1996). One of the factor to improve students become more skillful in teaching or they are able to teach effectively, is that they must possessed physic content correctly. That is way methods, models, ways or teaching techniques in explaining physic subject are needed. Besides teaching method, to help students deal with their problem in comprehending physic concepts, books or physic teaching material is needed, in which the benefit itself could be experienced by students.

Alwasilah (2005) defines that teaching materials having important role in education system. In many forms of material teaching, printed or non printed is important in achieving the goal of education. On the same ideas Hayati (2000) says the role of material teaching in education process takes a strategic position and determines the goal of education. Material teaching is an instrumental input along with the curriculum, the teacher, the media used, and the evaluation. The quality of process and teaching result are influenced by material teaching that is used. That is why material teaching take a significant role in determining the goal of education. Most current physic literature, providing physic concept in verbal and mathematic. At the same time they give lake of explanation in picture and graphic or not always using them in every discussion, and as the result, many of students have difficulty in drawing event or in graphicing physic event. Besides that, there are many students have difficulty in explaining picture verbally or explaining graphic in physic event. This difficulty is caused because of material teaching that is used as refference sources is lack of exercises related to picture and graphic on physic event.

Physic concept in multiple representation, that are combining among verbal concept, mathematic concept, picture concept and graphic concept are very needed by students to apply them in physic learning. Mean while, students' verbal, mathematic, picture and graphic representation ability are expected increase, because by having this enough ability actually students have understand comprehensive physic concept, this is can be said that they are able to represent in verbal, mathematic, and also able to draw and to graph physic concept clearly. If students' verbal, mathematic, picture and graphic representation ability are increasing then the ability of their understanding physic concept will be growed up. It is also mean they will be able to explain the concept of physic to other person. That is why the mechanic material teaching which is able to raise ability of verbal, mathematic, picture and graphic is needed.

Concerning the issue above studying enough current physic material is considered important, so the development mechanic teaching material for increasing students

ability on representation of verbal, mathematic, picture and graphic is need to be implemented.

The main purpose of this research is to study the characteristic of teaching material for increasing students' ability on representation of verbal, mathematic, picture and graphic.

The characteristic of teaching material which is able to increase students' ability on representation of verbal, mathematic, picture and graphic is the teaching material that has writing pattern based on teaching material writing procedures that are: (1) Analysis; (2) design; (3) development; (4) evaluation; (5) revision (Belawati, 2006). Besides that, writing of teaching material also need to focus on the dividing path in every chapters, for instances in every chapter is divided into three parts that are: introduction, presentation, and graphic.

Exclusively, for mechanic teaching material characteristic, in the end of every chapter should be given an example of exercises together with their discussion that related with representation of verbal, mathematic, picture and graphic. In the part of presentation, concept mechanics are explained about their verbal concept, mathematic concept, picture concept, and graphic concept.

Representation is one of the good method and it is still growing to develop the understanding of physic concept to students. Because, the representation is able to point out thing and their natural activity. So, the difficulty that is caused by large of mentally picture influency can be solved. This is because of the process of physic event can be demonstrated, so the representation such as demonstration method can help to solve difficulty in learning physic that need a lot of involvement physic knowledge and mathematic logic (Dahar, 1989; Van den Berg, 1991). Representation can be used as for analyzing learning model, that is component of evaluation, it is consisting of ways for measuring learning process result. This idea is supported by Edward F. (2006) he says that model analysis for implementing qualitative research in building framework of quantitative representation can be obtained from the result of energy, model analysis for implementing qualitative research in building framework of quantitative representation can be obtained from the result of energy concept and energy movement. The same way, motivation of learning and low motivation on learning physic can be activated by learning physic through representation (Bruce W., 2006)

METHOD

This research tended to be a survey research in surprising on study of (1) literature; (2) subject description; (3) initial condition of material teaching and (4) former research result that related to representation and related to the teaching material development. Based on activity that going to conduct in this research, the data will be in qualitative descriptive. That data is obtained by observation technique, questionnaire, documentation and literature study through many sources, for instance: book, scientific journal, article, research report, etc. these are used as a secondary data. For obtaining data result and conclusion of studying, the data that is obtained will be analyzed by descriptive analysis.

Focus on this research was the mechanic teaching material for increasing studends'ability on representation of verbal, mathematic, picture and graphic. The respondent of this research were students of teacher training education physic department that take basic physic subject.

RESULTS AND DISCUSSION

1. Study related to physic representation

The former research result from other countries that related to representation of verbal, mathematic, picture and graphic that is obtained from scientific journal, article, and research report show that representation give good impact on students' performance and in increasing students' representatiion. Some of the researchs result could be seen in table 1 below.

Table 1. Research result related to physic representation

Year	Product and Researcher
2005	Format of different representation of atomic physic learning gives impact on students' performance. Patrick B. Kohl and Noah D. Finkelstein
2006	The analogy is very good using as EM wave, in which teacher should attended previously the representation for its interpreting. Noah S. Podolefsky and Noah D. Finkelstein.
2006	Learning environment having a certain role in developing modern physic representation. Using of different representation and selecting representation are able to promote students' representation acquirement. Patrick B. Kohl & Noah D.F.
2006	Representation of graphic sources is able to explain the raising form from transformation modern physic conceptual. Michael C.W.
2006	Multi-principal is very needed in learning mechanic and having potency for activiting the way of studying efectively. Bruce W., Vaughan Prain, Jim Carolan.
2006	Students' performance depending on the representation of the basic physic of complex problem and students have consistant opinion but lack of correlation with their performance. Patrick B. Kohl & Noah D.Fiinkelstein
2006	Analysis model for applying qualitative research to build quantitative representation framework could be obtained by energy concept and energy movements' test result. Patrick B. Kohl & Noah D.Fiinkelstein
2007	The using of vidio determines fundamental for concepting backward teacher training class and for helping to connect science theory and science practice. C. Paul Newhouse, Jenny Lane, and Claire Brown.

2. Study related to development teaching material

Based on the former research result, there are not found any associated with developing material teaching, inform that studying teaching material in which stress on the development of teaching material in which leads or increase ability on representation of verbal, mathematic, picture and graphic. Research stressing in developing teaching material presented on table 2 as follows:

Table 2. Research study related to development teaching material

Year	Product and Researcher
1993	Book has to contain four things that are: (1) science as basic knowledge; (2) science as investigation; (3) Science as way to thinking and (4) having interaction between science tehnology and society. Simansky, Kyle, and Alport.
1996	Material in a certain book that tough to understand and each convulted explanation related to the level of low legibility. Suhadi
1997	Ownership level of books positively related and significantly related with students' studying result. Supriadi
2005	Physic teaching material with the physic event photo analysis exercise in the process of physic teaching and learning on senior high school student can trigger the involvement of students' mental in aspect level concept achievement which tend in high category. Sutarto
2009	Basic physic material teaching for biology students consist of physic principle that is needed by students. The books including high category, the use of basic physic material teaching for biology student can improve their mastery of physic concept. Toto

3. Result of survey documentation and field observation

Result of syllabus analysis study and relationship between mechanic concept and representation on verbal, mathematic, picture and graphic. From the teaching material that

is used as the main reference, could be seen on table 3.

Table 3. Syllabus analysis

Concept	Representation			
	verb	m	pic	grap
Position and transmigration/ move	√	√	√	-
Rapid and speed	√	√	√	√
Accelaration	√	√	-	-
Uniform straight motion	√	√	√	√
Change uniform straight motion	√	√	√	-
Vector and scalar	√	√	√	-
Join and analyze a vector	√	√	√	-
Vector multiplication with scalar	√	√	√	-
Projectile motion	√	√	√	√
Relative velocity	√	√	√	-
Style concept	√	√	√	-
Newtons law	√	√	√	-
Friction force	√	√	√	-
Equilibrium condition	√	√	√	-
Equilibrium model objects	√	√	√	-
Uniform circular motion	√	√	√	-
Uniform changed circular motion	√	√	√	-
Planetary motion	√	√	√	-
Equation of rotational motion is accelarated	√	√	√	√
Moment of inertia	√	√	√	-
Rolling motion	√	√	√	-
Work by energy	√	√	√	-
Work relation and energy	√	√	√	-
Conservation of mechanical energy	√	√	√	√
Impuls and momentum	√	√	√	-
Conservation of momentum	√	√	√	-
Impact	√	√	√	-

Information
Verb ; verbal
Math ; mathematic
Pic ; picture
Grap : graphic

On table 3 shows, there are not all mechanic concepts representing graphic. If that study display mechanic sub-concept there must be more mechanic sub-concept that are not representing graphic and also not representing physic event picture. Based on above issue it is a must to design mechanic teaching material character that capable to increase ability of representation of verbal, mathematic, picture and graphic that appropriate based on analysis and deep study, so it is ready to use by student and lecturer.

Mechanic teaching material which can increase ability of representation on verbal, mathematic, picture and graphic has characteristic that are: has sequence chapter title, title of sub chapter, material description in which represent concept verbally, mathematically, picture, graphic, example of exercise, test capability and the last is biblography. The example of exercise could be seen as follows:

A ball thrown upward horizontally from cliff top with hundred meter high.

a. a. How fast the ball must leave the cliff top if landed on the ground that has 90 m distance from cliff foot

b. b. Analyze graphic y vs t, x vs t, v vs t

c.

The Solution: First step, we draw problem verbally so that we got first picture. On the picture source the y direction positif down ward, with the cliff top as y_o = 0 m so the cliff base is on y = 100 m. second find out the time that is needed by the ball to get the land under, using equation or similarity

$$y = v_0 t + \frac{1}{2} g t^2 \text{.....(1)}$$

For vertical direction (y), with y = 100 m and $v_{y0} = 0$, obtained $t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{2\,(100\ m)}{9{,}8\ m/s^2}} =$ 4,52 s

Picture 1. A ball thrown from cliff top horizontally

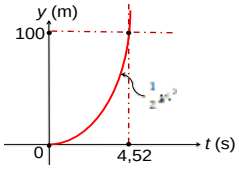
(a) Initial velocity v_{x0}, we can count using equation (2)

$$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2 \text{..... 2}$$

But this time using horizontal (x) with $a_x = 0$ and $x_0 = 0$, that is

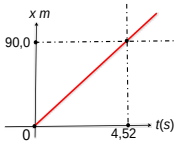
$x = v_{x0}t$ and, $v_{x0} = \frac{x}{t} = \frac{90\ m}{4{,}52\ s} = 19{,}9\ m/s$

So the ball must leave the cliff top horizontally with velocity $v_{x0} = 19{,}9\ m/s$



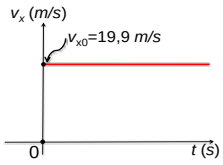
Grafik 1. Analisa grafik *y* vs *t*

(b) Relationship graphic analyze between ball vertical line with time, between ball horizontal line with time and direction velocity relationship with time that need into cliff base see graphic 1,2, and 3



Grafik 2. Analisa grafik *x* vs *t*

This problem representing the example of physic concept verbally (concept scientific explanations) mathematic (show by the using of equation 1 and 2), picture (show by graphic 1, 2, and 3)



Grafik 3. Analisa grafik v_x vs *t*

CONCLUSIONS

The study of research result shows that mechanic material teaching consist of the examples of mechanic principles application in picture context (photo) in physic event; and having certain writing pattern, that are: sequence chapter, Title or section title, sub-chapter title, material description, example of exercises, test of ability and bibliography

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