Characteristic of Wave and Magnet Textbooks (WMT) with RVGM-BASED to Train Student’s Critical Thinking Skills at Vocational High School

DiahTri Wahyuni¹, I Ketut Mahardika², Supeno²

¹Educations Postgraduate college student IPA, Jember’s university
²Educations Postgraduate lecturer IPA, Jember's university
Email :150220104016@students.unej.ac.id; ketut.fkip@unej.ac.id; supenofkip@unej.ac.id

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ABSTRACT

This research constitutes about the characteristic of WMT with RVGM-based to train Student’s critical thinking skills at vocational high school. The observational problem is how characteristic of WMT with RVGM-based to train Student’s critical thinking skills at vocational high school? This problem is enlightened deep two observational questions. First, what Binds WMT with RVGM-based application example comprising principle wave and magnet that train student’s critical thinking skills? Both of, how patterns to writing WMT with RVGM-based to vocational high school? This research constitutes development research binds textbooks, by use of mixed method exploratory model, which is gathered qualitatives data, then builds draft Physics Textbooks to becomes books validated ready. The subject in observational it is WMT with RVGM based that can train Student’s critical thinking skills at vocational high school. Meanwhile, its respondent is student braze XI at vocational high school. Data collecting tech is observation, questionnaire, essay, and document. Observational data to be described qualitatively. Result observational to point out that WMT with RVGM-based application example comprising principle Wave and magnet that train Student’s critical thinking skills; and has given writing pattern, which has chapter heading thread, chapter sub title, the breakdown of material, trifling example, summary, ability quiz problem, and literature.
INTRODUCTION

Science education have essential role in upgrade education according to education daring at globalization era. One part of science is physics that's very important. Physics reality ranges two a part, which is physics as product and physics as process. Physics as product covers a group comprise of science facts, concepts, and physics principles. Physics as process cover skills and proprietary attitude by scientist to get and develops physics product. That skill constitute process skills, meanwhile proprietary attitude by scientists is known as scientific attitude (BSNP, 2006).

Student not only being given by fact and concept, but student also being trained deep find fact and concept via processes and scientific attitude. It makes physics learning at schooled according to curriculum implement 2013 one utilizes scientific’ approach in processes its learning (kemdikbud, 2014). Scientific Approach can be said as process of learning that guide student to solve problem with ripe planning activity, thrifty data collecting, and data analysis to result one conclusion (Abidin, 2014). Learning with Scientific Approach can push student critical thinking, analytical, and correct deep identifies, understand, solving problem, and applies learning material (Hosnan, 2014).

One of study international hits cognitive ability student which is TIMSS (Trends in Mathematics and Science Study) one that arranged by IEA (International Association for the Evaluation of Educational Achievement). TIMSS’S result 2015 on Physics area points out Indonesia to get average value 397 whereas assess it lies under international average value which is 500. Based on data percentage average right answer for science content and domain cognitive in particular Physics, percentage is answer is right on understanding problem ever higher as compared to percentage answer is right on implemented problem and reasoning.

Understanding, implement, and reasoning aspect in cognitive ability domain as one is applied on TIMSS can be utilized to point out ability profile thinks student. Understanding and implement aspect includes in ability of basic think. Meanwhile reasoning aspect includes in high order thinking skills, critical thinking skills constitute one of form of high order thinking skills. Base TIMSS’S result therefore gets to be said that critical thinking skills Indonesian student still low. It can happen since deep student learning process less is stimulated to increase critical thinking skills.

Critical thinking is one part of high order thinking skills that gets convergent character. Ennis (1985) have developed skills fledged list critical thinking skills one cover: in focus on question, argument analysis, and assess is source credibility. Besides this specific skill, critical thinking also involves common traits of whereabouts situation is approached. Once more, Ennis has developed list that comprehensive who ranges to become gets open ended think, try to be informed with every consideration, and with regarding situation entire (Ennis, 1985).

BadanStandar Nasional Pendidikan (BSNP) 2010 states that there are eight competencies and / or skills that must be possessed by the human resources of the 21st century One of the eight competencies are Critical-Thinking and Problem-Solving Skills which Including critical, lateral, and systemic thinking skills, especially in the context of problem solving. Therefore, critical thinking skills become very important for students trained to compete with the Human Resources world wide. The process of constructing this critical thinking skill will be easier to do if the physics learning is done contextually for the students. Contextual learning is a concept of learning that emphasizes the interrelationship between learning materials with real life, so that
students are able to connect and apply the competencies of learning outcomes in everyday life (Mulyono, 2012: 40). Contextual learning can be supported by various contexts provided by teachers, including through the teaching materials used. Unfortunately, the availability of contextual teaching materials that physics is a constraint for teachers. Therefore we need a media that can train students’ critical thinking skills.

One of the learning media that can support learning and can train critical thinking skills is textbook. The textbook is a book that is used as a textbook in a particular field of study, which is a standard book compiled by experts in the field for instructional purposes and objectives, complemented by harmonized and understandable teaching tools by the wearers in schools and colleges so as to support a teaching program (Suherjono, 2008: 83). Mahardika (2012: 23) mentions that the book as a teaching material is a book that contains a science of analysis of the results of the curriculum in written form. The material in the textbook is the realization of the material listed in the curriculum.

Textbook can train critical thinking skills students should use the right approach. One approach that can be used is multiple representations approach for learning physics, students are required to master different representations (experimental, graphs, conceptual, formulas, drawings, diagrams) (Mahardika, 2013). According Izsak and Sherin in Mahardika (2012: 43) teaching by involving multiple representations provide a rich context for students to understand a concept. Display textbooks with various representations in the planting of a concept will be able to help students understand the concept learned. This is related to each student has a specific skills that is more prominent than other skills. There are students who are more prominent verbal skills than the spatial and quantitative skills, but some are otherwise.

Results of research by Widianingtiyas (2015) found that research using multiple representations approach in physics learning can improve students cognitive ability. The critical thinking skills is one part of students' cognitive abilities. Lestari Research (2015) shows that the implementation of multiple representation-based learning can improve students' conceptual understanding and critical thinking skills. Likewise, the research conducted by Mahardika (2013) which shows its significant influence between student learning outcomes apply the learning model Quantum-based teaching multiple representations with the model direct learning instruction on teaching physics in high school.

Based on the description, it is necessary to "Development of Wave and Magnet Textbooks (WMT) with RVGM-Based to train student’s critical thinking skills At vocational high school ". Associated with the above view, then this study's main purpose is to examine the characteristics of WMT with RVGM-Based To train students' critical thinking skills at vocational high school.

Characteristics of textbooks that can train students' critical thinking skills are textbooks that have a writing pattern based on the teaching-learning procedure, namely: 1) analysis, 2) design, 3) development, 4) evaluation, and 5) revisions (Belawati, 2006). In addition to writing based on the writing procedure, the author of the textbook should also pay attention to the division of each chapter, for example in each chapter is divided into 3 (three) parts namely the introduction, presentation and closing.

Particularly for the characteristics of WMT with RVGM-Based To train students' critical thinking skills, at the end of each chapter needs to be given examples of problems with discussions related to critical thinking skills, and examples of practice
questions. Then in the presentation, the concepts of wave and magnet are explained verbal concepts, concept images, and mathematical concepts, all of which are aimed at improving students' critical thinking skills.

METHODS
This research led to the survey research, with emphasis on the study of: 1) early referenced source books; 2) subjects description; 3) The initial conditions text books; and 4) the results of previous research related to representation, critical thinking skills, and are associated with the development of textbooks. Based executed study activity deep observational, therefore study data is descriptive qualitative. The data obtained by observation, questionnaire, document, and literature to various sources, such as: books, scientific journals, articles, observational reporting etc as secondary data. To obtain the results and conclusions of the study, the data obtained were analyzed by descriptive analysis.

Subjects in this research is WMT with RVGM-Based that can train students' critical thinking skills at vocational high school. While respondents in this study are students of class XI vocational high school.

RESULTS AND DISCUSSION
1. The Result of The Theory
   a) Study Related to Physical Representation
   The results of previous studies in several countries related to multiple representations, including verbal, image, and mathematical representations, obtained from scientific journals, articles, and research reports indicate that representations can have an impact on conceptual understanding, can enhance students' cognitive abilities, including critical thinking skills. Several research results are shown in Table 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Product and Researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Research using multi representation approach in physics learning can improve students cognitive ability. LarasWidianingtiyas</td>
</tr>
<tr>
<td>2013</td>
<td>The use of chemical bond textbooks with constructivist approach and multiple representation able to improve student's learning achievement. Herlian</td>
</tr>
<tr>
<td>2015</td>
<td>Implementation of multiple representation-based learning can improve students' conceptual understanding and critical thinking skills. Putri Lestari</td>
</tr>
<tr>
<td>2013</td>
<td>There is significant between student learning outcomes are applying the learning model based Quantum Teaching multiple representation with direct learning model of instruction in the teaching of physics in high school. I KetutMahardika</td>
</tr>
</tbody>
</table>

   b) Study Related to Development of Textbook
   The results of previous research related to the development of textbooks, informed that the study of textbooks that emphasize the development of textbooks that are multiple representation basis and train critical thinking skills is still very minimal. From the results of the study, it was found that research
emphasis on textbook development as presented in table 2.

Table 2: Study Studies Relating to Development of Textbooks

<table>
<thead>
<tr>
<th>Year</th>
<th>Product and Researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>There is a significant difference in the students’ learning outcomes using inquiry model and multi-representation LKS with Using conventional learning in physics learning in high school. I KetutMahardika</td>
</tr>
<tr>
<td>2012</td>
<td>The multiple representation approach used in interactive conceptual learning programs has a relatively high effectiveness in instilling a conceptual understanding of energy- endeavors among students. A. Suhandi and FC Wibowo</td>
</tr>
<tr>
<td>2016</td>
<td>There is a significant influence of guided inquiry model of integration of peer instruction with multiple-representation LKS on verbal and mathematical representation ability. I KetutMahardika, Yushardi, and Ida Ayu.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Product and Researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>The use of chemical bond textbooks with constructivist approach and multiple representation able to improve student's learning achievement. Herlian</td>
</tr>
<tr>
<td>2013</td>
<td>1) Textbooks loaded values of characters developed have validity in very high category. 2) The textbook is loaded with very practical character values used in Physics learning in grade XI SMAN 1 BatangAnai. 3) The textbook is loaded with effective character values used in the implementation of Physics learning in class XI SMAN 1 BatangAnai is characterized by increasing the average value of cognitive, affective average value and psychomotor value of students. Mila Anggela, Masril, and Yenni Darvina</td>
</tr>
<tr>
<td>2012</td>
<td>The development of textbooks on SETS-oriented Biotechnology materials is appropriate for use in learning for high school students in Class XII. Elina S. Millah, Lukas Suhendra, and Isnawati.</td>
</tr>
<tr>
<td>2012</td>
<td>Window textbooks on reproduction system materials for the developed RSBI Junior High School are eligible for use in the learning process at RSBI, as they have met the eligibility of the study, the feasibility of the learning outcomes, and the feasibility of the students’ responses. Habibatul Barroh, Endang Susantini, and Nur Ducha</td>
</tr>
</tbody>
</table>

c) Studies Relating to Critical Thinking Skills

Previous research results relating to training and enhancing critical thinking skills, informed that the application of textbook learning and study that emphasizes the effort to practice critical thinking skills is still very rare. From the results of the study, it was found that research emphasis on improving critical thinking skills is presented in Table 3.

Table 3: Research Studies Associated with Critical Thinking Skills

<table>
<thead>
<tr>
<th>Year</th>
<th>Product and Researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Implementation of multiple representation-based learning can improve students' conceptual understanding and critical thinking skills. Putri Lestari</td>
</tr>
</tbody>
</table>
The use of scientific approach has an effect on improving students' critical thinking skill 28.23%. Pratiwi

The study of chemical equilibrium materials uses an effective scientific approach to the students' skills in evaluating. Saputri

2. Survey Results, Documentation, and Field Observation

The results of the study of syllabus analysis, and the relationship between wave and magnetic physics concepts with verbal, image, and mathematical representations (RVGM), from the initial teaching material used as the main reference can be shown in table 4.

Table 4: The relationship between wave and magnetic concepts with RVGM

<table>
<thead>
<tr>
<th>Concept</th>
<th>Representasi</th>
<th>Verb</th>
<th>Gbr</th>
<th>Mtk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wave</td>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Vibration on Pendulum and Spiral Spring</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Period and Frequency</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pendulum oscillation speed</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Transversal's wave</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Longitude wave</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Walking wave</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Stationary wave</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Sound wave</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Concept implement</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Magnet</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Magnet induction</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Magnetic field by electricity current</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Magnetic field by circle wiring</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Magnetic field by solenoid</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Magnetic field by toroida</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Electricity and magnetic field power</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Bobbin in magnetic field</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Magnetic field using up | V | V | V
Electric measuring instruments | V | V | V
Electromagnetic wave | V | V | V

Information:
Verb = verbal,
Mtk = mathematical,
V = there is representation, and
Gbr = image,
- = no representation

In Table 4 appears, that all concepts and magnetic waves represent verbal, images, and mathematical. Because it needs to be designed character physics textbook and magnetic waves VGM-based representation that is able to train critical thinking skills are appropriate based on the analysis and in-depth study so it is ready for use by students as well as a physics teacher.

WMT with RVGM-based that is able to train Critical thinking skills Has the characteristics that is: has a chapter title sequence; Sub chapter titles; description of the material in it representing the concept verbally, images, and mathematical; problems example; And ability test questions; summary; As well as bibliography. An example of a study on verbal representations, images, and mathematical, images can be shown in the following example problems.

A sphere whose mass is 0.1 kg is suspended on a vertical spring having a spring constant of 20 N / m. The ball is initially sustained by the hand, so that the spring is neither stretched nor compressed. The hand is removed, so the ball drops and the spring is stretched. When the air resistance is negligible, how far does the ball fall before it is stopped momentarily by the spring?

Resolution:
The first step we illustrate the problem of the verbally, so that obtained image 1.

![Diagram of a sphere on a spring with hand and spring in different positions](image)

Figure 1. Left picture of position when spring and sphere are neither stretched nor compressed (hand held). Right image after hand is released.

Because interference air ignored, therefore implement law energy eternity on this case is:

Because interference air ignored, therefore implement law energy eternity on this case is:
\[
\left( \frac{1}{2}mv^2 \right)_{\text{initial}} + (mgh)_{\text{initial}} + \left( \frac{1}{2}kx^2 \right)_{\text{initial}} = \left( \frac{1}{2}mv^2 \right)_{\text{final}} + (mgh)_{\text{final}} + \left( \frac{1}{2}kx^2 \right)_{\text{final}} \quad \cdots (1.1)
\]

On initial state, spiral spring was stretched, so
\[
\left( \frac{1}{2}kx^2 \right)_{\text{initial}} = 0 \quad \cdots (1.2)
\]

If on balls final situation deviate in as much as d of situation initially, therefore spiral spring is stretched in as much as d, so its elastic potential energy is:
\[
\left( \frac{1}{2}kx^2 \right)_{\text{final}} = \frac{1}{2}kd^2 \quad \cdots (1.3)
\]

On initial state, ball lies in as much as d above final positioning, so:
\[
(mgh)_{\text{final}} = 0 \quad \cdots (1.4)
\]

Therefore:
\[
(mgh)_{\text{final}} = mgd \quad \cdots (1.5)
\]

The ball is released from rest and eventually stops moving. Means the initial kinetic energy and finally is:
\[
\left( \frac{1}{2}mv^2 \right)_{\text{initial}} = \left( \frac{1}{2}mv^2 \right)_{\text{final}} = 0 \quad \cdots (1.6)
\]

Thus, hokum is energy’s eternity results:
\[
mgd = \frac{1}{2}kd^2 \quad \cdots (1.7)
\]

So is gotten:
\[
d = \frac{2mg}{k} = \frac{2(0.1)(10)}{20} = 0.1m = 10cm
\]

**CONCLUSION**

Study to result research points out that Physics Textbooks Wave And Magnet RVGM- Based application example comprisings principle wave and magnet that train critical thinking of student; and has given writing pattern, which is have chapter heading thread, chapter sub title, breakdown of material, trifling example, and ability quiz problem, summary, and literature.

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