

The Influences of Mathematics Ability toward Physics Learning in Senior High School Based on an Authentic Assessment System

Aida N. Safitri, Rosita Sari, and Sri Wahyuni

Departemen of Physics Education, Universitas Jember, St. Kalimantan 37, Kampus Tegal Boto, Jember, East Java, Indonesia

Email: asafitri905@gmail.com, rositasirasio@ymail.com and sriwahyuni.fkip@unej.ac.id

Abstract—Physics is science which in its learning there are some products i.e. theory, fact, concept, law and formula. So that to understand physics lesson, students not only need a theory or concept but also the mathematical calculation to solve physics problem through formula or equation. It can be taken from mathematics lesson which obtained by students. The study to know the influences of mathematic ability towards physics base on an authentic assessment system. Based on the studies have been discussed, is obtained that mathematic have relatedness with learning of physics. Mathematics ability gives effect towards students' physics cognitive aspect in Senior High School. The influences of mathematic ability toward students' physics affective and psychomotor aspect are not known certainly, consider there are not the research which discussing that.

Index Terms—physics, mathematics, authentic assessment

I. INTRODUCTION

Education is one of the important problems of human life. Human must be going to competitive in era development. Education useful to produce good human resources for managing nature resources effectively and efficiently. In the implementation of education is influenced by the curriculum, education, infrastructure, and evaluation of learning outcomes, and students.

The new curriculum is implemented in Indonesia is curriculum 2013 which start on 2013-2014 academic year [1]. Curriculum as one of the things that influence education must be going to flow the era development so that quality of education keep existing. Therefore, the curriculum in Indonesia has changed many times. Of course, it's done in order to improve the quality of education in Indonesia better. One of emphasis in the curriculum 2013 is using authentic assessment [2].

Authentic assessment is the assessment that measures students' abilities based on three aspects, including the knowledge aspect, attitude aspects, and skills aspects adapted to the characteristics and abilities of students in each level. Authentic assessment is an alternative assessment for the teacher to evaluate students' ability in learning [3]. Authentic assessment invite the students to

use academic knowledge in real-world context for meaningful goals [4]. Authentic assessment in curriculum 2013 focused on science through capability-based assessment be output through the process, portofolio and output assessment completely and thoroughly [5].

Physics lesson in Senior High School was developed with reference to the characteristics physics that is intended to educate and train the students in order to develop competency i.e. observation, experiment and scientific thinking and science behavior [6]. In physics learning, students not only study the concept, law, theory or formula, but also study how to use the concept to solve physics problem with calculation [7].

The factors that affect learning outcomes of physics are the effect of the student's ability in the mathematics learning. Mathematics is a basic science that must be mastered easier by students to learn physics. In physics, mathematics places a major role in its ability to solve physics problems from simple to the most complex forms, mathematical very helpful one's in exploring the intricacies of physics that fact was not easy [8].

Previous research has been discussed the influence of mathematic ability to learning outcomes of physics. However, previous research conducted discuss only from the aspect cognitive, even though we know students who have low cognitive value is not necessarily the value of affective and psychomotor also low. Therefore, the lack of aspects assessment used to determine the influences of mathematic ability toward physics makes authors conducted a study based on literature study to assess the influences of mathematic ability toward physics (cognitive, affective, and psychomotor aspect) in Senior High School base on an authentic assessment.

II. PURPOSES OF THE STUDY

The purposes of this study are (1) to know relatedness between mathematic and physics (2) to know the influence of mathematic ability toward physics cognitive aspect (3) to know the influence of mathematic ability toward physics in affective aspect (4) to know the influence of mathematic ability toward psychomotor aspect.

Manuscript received November 29, 2015; revised February 1, 2016.

III. LITERATURE REVIEW

A. Authentic Assessment

Assessment in education is a process of collecting data or information about results of student learning, then the data that has been obtained will be reprocessed to determine or measure achievement of student learning outcomes.

In curriculum 2013 to reinforce there is displacement in the assessment, from assessment through the test (measuring the competence of knowledge based on the result), toward authentic assessment (measuring the competence of attitudes, skills and knowledge based on the process and results) [2].

The cognitive aspect closely related to intellectual learning outcomes. This aspect includes several parts including, knowledge or memory, comprehension, application, analysis, synthesis, and evaluation. The affective aspect related to attitude. This aspect includes on, the invention an answer or response, assessment, organization and internalization. Psychomotor aspect closely related to the results of the skills and ability to act. This aspect includes reflex, aspects of basic movement skills, perceptual abilities aspect, the aspect of harmony or accuracy and expressive and interpretive aspects of movement [9].

Ref. [2] that teachers can do assessment competency of students' knowledge by using a variety of ways, including through written tests using items, an oral test by asking directly to the students using a questionnaire, and assignment or a project with a specific worksheet to be done by students in certain period of time. Furthermore, Kunandar also states that teachers can make an assessment based on an authentic assessment in the competence students' attitudes by using a variety of ways, such as through observation, self-assessment, peer assessment, journal assessment, and interview.

Imas Kurinasih and Berlin Sani also explained that teachers assess students' skills using performance assessments, product, project, and portfolio [10].

Authentic assessment refers to the Assessment of Standard Reference, namely the achievement of learning outcomes is based on scores position earned toward an ideal score (maximum). Thus, the achievement of students not in the context compared to other students, but compared to certain standards or criteria, the Minimum Completeness Criteria [2].

B. Mathematics Ability

Mathematics is a universal science that underlies the development of modern technology, have an important role in a variety of disciplines and advance human thinking power [11].

Mathematics is used as a means of logical reasoning according to certain premises. Results of experiments to find a relationship between the amount of two pieces can be formulated in the form of mathematics. Mathematics also serves to develop the ability to calculate, measure, lowering and using mathematical formulas that are required in everyday life through the material

measurement, geometry, algebra, and trigonometry. Mathematics also serves to develop the ability, to communicate ideas with mathematical equations, diagrams, graphs, or tables [9].

Mathematical ability is the ability that has been owned by the students after getting the material given by the teacher of mathematics. Three categories of mathematical ability (mathematical abilities) according to Yulia Kavas, namely: (1) Understanding Number, (2) Non-Numerical Processes, (3) Computation and Knowledge. Understanding Number is the ability of numbers and algebra process to be used when resolving problems of the calculation. Non-Numerical Processes is the ability to understand mathematical processes that do not numbers and understand concepts such as rotation or reflection symmetric and other spatial operations. The question that is does not contain a significant number to consider the child. While Computation and Knowledge are the ability to perform simple calculations using the methods of paper- pencil and recall math facts and its terms [12].

One of the three categories of math skills that mentioned on above, then suitable for learning physics in Senior High School is the calculation of Understanding Number, which is in the form of operating figures to solve problems such as physics calculations using equations or formulas.

C. Physics Learning in Senior High School

Physics is science that much about nature and symptoms, from real (visible) to abstract or even simply in the form of a theory that the discussion involves the ability of imagination or involvement a strong mental [13].

Physics related how to find out about nature systematically, so that science is not just mastery of collection the knowledge, such as facts, concepts or principles but also a process of discovery, so that it can develop the ability to inductive and deductive analytic thinking in solve the problems associated with using the equation (formula) and can develop the knowledge, skills and confidence attitudes [14].

In learning of physics, students not only learn the concepts or formulas but also learn how to use physics concepts to discuss issues that may be questions of physics. To understand the physics well are required the ability to apply various formulas in accordance with the processes and procedures to solve physics problems [7].

Learning physics starts in the elementary school education unit but the scope of the discussion is still very common, it is different in the middle and high school. The purpose of physics learning in secondary schools, in general, is to give knowledge about physics, the ability in process skills and increase creativity and scientific attitude [3]. The learning process of physics emphasizes providing direct experiences to develop competency, in order to explore and understand the surroundings scientifically [15]. An authentic learning environment should be designed with the authentic context that reflects how knowledge will eventually be used in the real world. Therefore, this learning environment was designed to simulate as closely as possible a real-world scenario in

which students may face in the working world [16]. Students should be given the opportunity for doing experiments or lab work using a physical object which is supported by the interaction with peers and assisted by a teacher's question [17].

Based on the above explanation, we can understand that in the teaching of physics is not limited to give a product in the form of theory or formula to students, but must also fully engage students to develop their skills to provide hands-on experience for students.

IV. DISCUSSION

First, to know the relatedness between mathematic and physics. Physics is one field of science which discussing natural phenomena based on facts, concepts and principles exist to be studied so as to produce a theory or law. In physics learning in the classroom a lot to teach the theory, computation and experiment. Almost all the material in physics requires mathematical calculations in the solution. Surely this mathematical calculation obtained from mathematics lesson. It can be said that the mathematic ability obtained by students is the basic to learning physics easier. To understand the physics well, needed the ability to apply various formulas in accordance with the processes and procedures to solve physics problems [7].

Ref. [8] Utari gave results that achievement of students reasoning thought ability not yet used optimally, understanding and reasoning have a relationship substantially to the understanding of the concept of mathematics and physics, so the ability and students' understanding of mathematic concepts is indispensable in supporting the physics. Based on the above, it is known that mathematics have relatedness with physics.

The second discussion to know the influence of mathematic ability of students toward the cognitive aspects of physics students. In classroom learning, cognitive values of physics obtained based on the written test conducted teacher to determine the extent to which students are able to understand the material or knowledge which have been given.

It has been mentioned above that have relatedness the mathematics of physics, then it is definitely mathematic ability have an influence on cognitive aspect of physics.

The above statement is supported by research conducted by Ika Fitri Rahayu mentioning, that there is significant influence between basic math ability and study habits to learning outcomes physics class XI IPA SMAN 11 Pekanbaru either partially or simultaneously. Data acquired basic math skills of students with basic skills tests developed in the 12 questions in narrative form. While studying physics results obtained from the examination semester physics student, especially the questions in the form of a count of the number of 10 questions in the form of objective and 3 problems in the form of description [18].

Similar research says the same thing conducted by Tri wardanik. From the study, says that there is the influence of early high and low categories mathematic ability of students on physics cognitive aspect. That is, students

who have prior knowledge of higher mathematics category has the cognitive abilities better than the students who have prior knowledge of lower mathematics categories [8].

The third and fourth discussion to know the influence of mathematic ability of students to the affective and psychomotor aspects of physics students. Affective aspects related to attitude. Affective aspects that can be observed from the students' attitudes is social or spiritual attitude shown students when learning. The attitude of students that can be measured easily when learning physics class is when a group or experiment. Social attitudes that often appear in the students is the scientific attitude as a great curiosity, asking, initiative etc. While aspects of the psychomotor skills associated with the results and the ability to act. Teachers can assess student skills in psychomotor aspects of using performance assessments, product, project, and portfolio. Psychomotor aspects of students in physics can be measured by the time when the students doing experiment to operate certain laboratory equipment.

From the discussion above, we know that mathematic related to physics and mathematic ability influence the cognitive aspects of physics students.

Ref. [19] the study are performed on all students of class XI MAN Tegal Babakan school year 2012/2013 states that mathematic ability influence the learning achievement of cognitive, affective and psychomotor learning chemistry. A similar study conducted by Mawan on students of class X SMA 3 Magelang school year 2009/2010) entitled Learning of Chemistry through TAI and GI Method GI in Terms of Initial Ability and Students' Mathematic Ability, there is the influence of high and low mathematical ability for accomplishment cognitive learning ($p = 0.013$) and affective ($p = 0.045$) but no effect on psychomotor learning chemistry [12]. Although this research was conducted to study chemistry, but do not rule out the possibility that the mathematic ability also influences the affective and psychomotor aspects of learning physics. Consider that chemistry and physics one master of Science. Until now to influence the ability of mathematics to students' affective, and psychomotor aspects of learning physics no related research conducted.

V. CONCLUSION

So, it is understandable that mathematics have related to physics. In physics learning, there are mathematical calculations to solve the problem using equations or formulas. Based on previous studies, mathematics ability greatly influences the cognitive aspects of physics in Senior High School. The influence of Mathematic ability towards physics in affective and psychomotor aspects are not known certainly. Consider there are not the research which discuss about that.

ACKNOWLEDGMENT

This work was supported in part by Jember University, Indonesia.

REFERENCES

- [1] I. Kurniasih and B. Sani, *Lesson Text Book based on Curriculum 2013*, 1 st ed, Surabaya: Kata Pena, 2014, p. 2.
- [2] Kunandar, *Authentic Assessment (Assessment of Learning Outcomes of Students Based Curriculum)*; Jakarta: Rajawali Pers, 2014, pp. 35-36.
- [3] Bektiarso, "The main of initial concept in learning of physics," *Saintifika Journal*, vol. 1, no. 1, pp. 11-20, July 2000.
- [4] E. B. Johnson, *Contextual Teaching and Learning*, California: Corwni Press, 2002, ch. 7, p. 288.
- [5] Ngadip, "Concept and types of authentic assessment," *E-Jurnal Education Office Surabaya*, vol. 1.
- [6] Mundilarto, "Integrated evaluation in physics learning," Unpublished, Essay, Yogyakarta: UNY, 2001.
- [7] M. Irianti, "The increase of problem solving ability and degree of students' mastery using heuristic process in learning of basic physics 1," *Sosiohumaniora Journal.*, vol. 10, no. 3, pp. 10-15, 2008.
- [8] Wanhar, "Relationship between mathematics capabilities concept with solving math problems," *Baruga Journal.*, vol. 1, no. 3, pp. 100-115, 2008.
- [9] T. Wardanik, "Learning of physics using direct instruction (at) methods to evaluated early mathematics ability highlights in circular motion irregularly in senior high school year 2008/2009," Unpublished. Essay, Surakarta: Universitas Sebelas Maret, 2009.
- [10] I. Kurinasih and B. Sani, *Implementation of Curriculum 2013: Concepts dan Application*, Surabaya: Kata Pena, 2014, p. 25.
- [11] S. Lestari, "Improving learning outcomes of mathematics through contextual approach in class II elementary school students iii bubakan girimarto district of wonogiri year 2009/2010," Unpublished. Essay, Surakarta: Universitas Sebelas Maret, 2010.
- [12] M. A. Riwanto, "Learning of chemistry through TAI and GI method gi in terms from initial ability and students' mathematic ability," thesis, Sebelas Maret University, Surakarta, Indonesia, 2010.
- [13] Sutarto, "Textbook physics (BAAF) with task analysis genesis photo physics (AFKA) as aids control concepts of physics," *Education and Culture Journal*, vol. 11, no. 54, pp.326-340, 2005.
- [14] Depdiknas, *Competence Standart of Sains Lesson in Senior High School*, Jakarta: Balitbang Departement of Education, 2003.
- [15] Depdiknas, *Competence Standart of Sains Lesson in SMA*, Jakarta: Balitbang Departement of Education, 2006.
- [16] H. T. Yeen-Ju and N. Mai, "Leveraging web technologies for collaborative problem-solving in an authentic learning environment," *International Journal of Social Science and Humanity*, vol. 6, no. 7, p. 537, July 2016.
- [17] S. P. Sukartini and M. I. Faisal, *Science and Education Applications*, Bandung: IMTINA, 2009, pp. 131.
- [18] I. F. Rahayu, "The influences of mathematic basic and study habit toward learning outcomes of physics in eleven grade science 11 pekanbaru senior high school," thesis, Riau University, Pekanbaru, Indonesia, 2011.
- [19] A. Agus. (March 2014). Chemistry Learning using Guided Inquiry Method and Learning Cycle 5e in Terms of Analytical ability and Mathematical ability. [Online]. Available: <https://downloadilmiah.wordpress.com/2014/03/18>



Aida N. Safitri was born in Situbondo, on 5 March 1995. Primary school, junior high school, and senior high school, completion in the district Situbondo, East Java, Indonesia. Primary school education taken in SDN 6 Mimbaan, junior high school education taken in SMPN 1 Panji, and senior high school taken in SMAN 2 Situbondo. University taken in Major Mathematics and Science Education, The Program Physical Education, The Faculty

of Teaching and Learning, University of Jember. She was during this as a student of 2013 fifth semester. Her hobby against writing it started out of senior high school when following the competition of since called KIR (scientific work teenagers). The beginning of study in university escaped selection first research PKM (program creativity college students) funded research by the directorate general of higher education (dikti).



Rosita Sari was born in Situbondo, on 29 July 1995. Primary school, junior high school, and senior high school, completion in the district Situbondo the East Java, Indonesia. Primary school education was in SDN 1 Olean, junior high school education taken in SMPN 3 Situbondo, and senior high school taken in SMAN 2 Situbondo. University taken in Major Mathematics and Science Education, The Program Physical Education, The Faculty

of Teaching and Learning, University of Jember. She was during this as a student of 2013 fifth semester. Started writing since follow a writing competition scientific held in senior high school called KIR (scientific work teenagers). The beginning of study in university escaped selection first research PKM (program creativity college students) funded research by the directorate general of higher education (dikti).



Sri Wahyuni was born on December 15th 1982 in Sidoarjo. She is Lecturer of Physics Education Department, Universitas Jember. She graduated in 2004 from Physics Education Department Universitas Jember. In 2010 She graduated from post graduated science education Universitas Negeri Surabaya with thesis about developing virtual laboratory based teaching material in junior high school.

In 2013 and 2014 she got grant for research from DIKTI (Directorate of Higher education) about developing macromedia flash based teaching material for improving student's critical thinking skills in junior high school.

She became member of ALSI (Assosiation of Lesson Study Indonesian), organization that care about learning and teaching of Indonesia. She became participant or member in national conference. The title of scientific articles, under the title "Developing WEB-Based Performance Assesment in Integrated Science Course" and published as Indonesian Journal of Science Education.