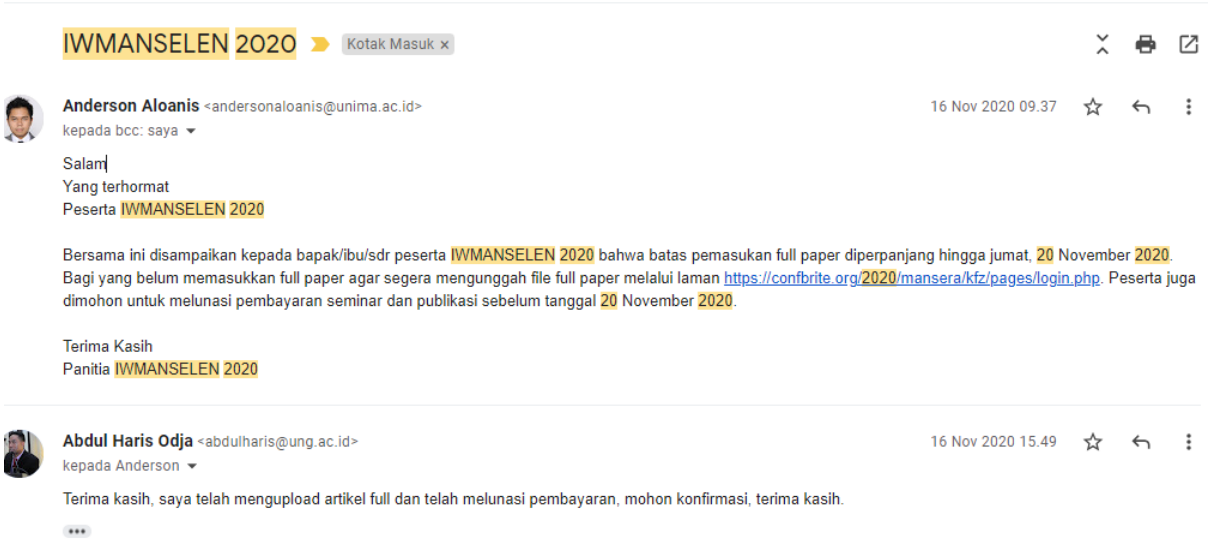
7. A **development** of **multiple representation-based** integrative **science learning** set to **improve scientific literacy** in the concept of heat.**"**



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Anderson Aloanis <andersonaloanis@unima.ac.id> 16 Nov 2020 09.37

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Terima Kasih
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Abdul Haris Odja <abdulharis@ung.ac.id> 16 Nov 2020 15.49

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Terima kasih, saya telah mengupload artikel full dan telah melunasi pembayaran, mohon konfirmasi, terima kasih.

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2	**[ABS-38 PAYMENT_PROOF] Development of Integrated Science Learning Tools Based on Multiple Representations to Improve Scientific Literacy** *Abdul Haris Odja* **Server time** : Tuesday, 13 October 2020 - 15:05:52 **File** : payment_proof (File ID 12, application/pdf: 11.1 kb) **Topic** : Education **Paid amount** : IDR 1,125,000 **(Make sure that it is correct)** **Payment date** : 2020.10.13 **(Make sure that it is correct)** **Info** : Yth Panitia, Kami melakukan pembayaran mendapatkan potongan 50% sesuai kesepakatan AMLI. Kami termasuk dari 5 peserta yang ditunjuk Dekan FMIPA UNG untuk mendapat potongan tersebut, terima kasih.
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A Development of Multiple Representation-Based Integrative Science Learning Set to Improve Scientific Literacy

Abdul Haris Odja
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Dikomentari [XX1]: Secara umum kalau dilihat dari sisi konten, paper ini masih blm sepenuhnya sesuai dengan scope publisher IOP. Mohon ditambahkan pada bagian results tentang konten/materi science nya yang menjadi isi dari materi pembelajaran. Arah paper ini tidak hanya mengukur "gain" tapi dimunculkan strategi pembelajaran science nya.

Abstract

This research has been conducted to, first, develop multiple representation-based integrative science learning set which encompassed lesson plan, student worksheet, teaching material (student book), scientific literacy test, and conceptual understanding; and second, find out impact of development of multiple representation-based integrative science learning set on scientific literacy skill and conceptual understanding of Natural Science. It was an Education Research and Development (R & D) that referred to 4-D method. After went through research stages, a product was created in the form of learning set and comprised Lesson Plan, Student Worksheet, Student Book, and Scientific Literacy Test and Conceptual Understanding of Heat (Natural Science). The learning set has been assessed by expert in his/her field and user in the field. Result of validation revealed that the generated learning set was categorized as good while result of experiment for the learning set found an improvement in students' scientific literacy skill and conceptual understanding of Natural Science. The previous results were supported by value of gain for 0,42 and 0,53, which were included in medium category.

Keywords: scientific literacy, integrative science, multiple representation

Dikomentari [XX2]: Untuk paper prosiding, tidak perlu ada kata kunci

Introduction

Result of learning evaluation based on high-order thinking skills, especially scientific literacy, reading and mathematics conducted by PISA (Programmer for International Student Assessment) and TIMMS (Trends International Mathematics and Science Study) on Indonesian students is low compared to Asian and world countries. A report from the Organization for Economic Cooperation and Development (OECD) through PISA in 2009 related to the ability to read scientific literacy, mathematics puts Indonesia in 57th place out of 65 countries. Compared to other Asian countries, Indonesia was at the bottom of the list (PISA, 2010). The same results were obtained in a study conducted by TIMMS (2011), which placed Indonesia in 40th place out of 45 participants with an average score of 406 (Michael et al., 2012).

The study conducted by PISA was also conducted by the Organization for Economic Cooperation and Development (OECD). The purpose of implementing educational evaluation is to improve the quality of education that focuses on scientific, reading, and mathematical literacies. This effort is believed to be influential for economic level of member countries. It is known that countries that perform a good performance in the PISA evaluation have on average developed economies and technology.

The low ability of students' scientific literacy is a basis for government to revise the 2006 to 2013 curriculum. Natural Science learning in SMP (Junior High School) level emphasizes two primary matters in the 2013 curriculum, which are first, Natural Science is developed as an integrative science subject, not as a scientific discipline education. Second, it is an applicative-oriented education, developing thinking skills, learning abilities, curiosity, and developing a caring and responsible attitude towards the social and natural environment.

The application of Natural Science learning is currently done separately or partially, even though it is taught by the same teacher. Concept of physics is taught separately from concepts of biology and chemistry. The 2006 curriculum has made it possible due to each concept is separated by time, for example, in class VII, semester one is dominated by physics material while semester two is more about biology lesson. The application of integrative science learning allows students individually and in groups to interpret Natural Science holistically and authentically. Occasionally, students interpret a concept with the same meaning differently when learned conventionally (not integratively). For example, the concept of energy, if it is not studied integratively, its understanding and meaning will be different from the concepts of physics and biology.

The integration of several science sub-concepts that are interconnected with one another is expected to be able to create more meaningful concepts of science than a learning whose topic is taught separately (partially). The low scientific literacy skills of Indonesian students are often caused by partial Natural Science

teaching while to respond the evaluation of scientific literacy by PISA requires a holistic conceptual link to concepts of science. The learning experience shows relation of learned conceptual will form a cognitive schema so that students get the wholeness and unanimity of the knowledge of Natural Science competencies holistically.

Integrated Science learning is one of the integrated learning. The learning strategy is based on an integrated curriculum approach that aims to create learning that is relevant and meaningful for students. According to Forgaty (1991), there were ten curriculum models starting from a highly fragmented subject-oriented curriculum to an integrated learning model. The ten models were grouped into three classifications, namely: (1) Single disciplines which covered: Fragmented, Connected, and Nested Models; (2) Across several disciplines which covered: Sequenced, Shared, Webbed, Threaded, and Integrated Models; and (3) Within and across learners which covered: Immersed and Networked Models

In addition to the integrated presentation of Natural Science topic, it must also pay attention to two realms of thought that are emphasized in core competencies, namely: concrete and abstract. One strategy for presenting topic that can cover both realms is multiple representation-based learning. Multiple representation is a way of teaching a concept in various ways and forms.

Representation supports students' understanding of physical principles or concepts by providing mental "pictures" for ideas. In addition, by producing and handling external representation, students construct cognitive of the situation or process being considered, thereby facilitating students' understanding on the basic principles (Ibrahim & Rebello, 2012).

Dikomentari [XX3]: Pada bagian akhir paragraf introduction, tuliskan Kembali tujuan penelitian secara singkat

Research Methodology

The research design used the Education Research and Development (R & D) method, which referred to the 4-D proposed by Thiagarajan, Semmel, and Semmel (1974), which consisted of 4 stages, namely definition, design, development, and dissemination. However, this research was conducted only up to the development

stage. The development stage is limited to limited testing by calculating the gain of students' scientific literacy skills on initial and final tests.

Research Finding and Discussion

In the definition, initial-final analysis, student analysis, concept analysis, task analysis, indicator specification, and learning objectives were carried out. At the initial-final analysis stage through observation, the researcher found several trends in the Natural Science learning including: teachers teaching Natural Science separately (partially) between physics, chemistry, and biology subjects; (2) the Natural Science learning was carried out through only one verbal representation (explanation) using blackboard media. This analysis was carried out to examine the characteristics of students that were in accordance with design and development, which included students' initial skills (student experience), both as individual and group through theoretical studies and previous research. Concept analysis and assignment were adjusted to the concepts in accordance with the proposed research material.

The design stage aimed to design a prototype of the multiple representation-based Integrative Science learning set. At this stage, a prototype of a learning set was produced in the form of an initial design of lesson plan, student book, teacher manual, student worksheet, and scientific literacy test and mastery of Natural Science concepts.

The purpose of the development stage was to produce a revised multiple representation-based Integrative Science learning set through expert validation, input from simulation result, and based on experimental data. The validation was carried out by 3 people, who were eligible to assess based on researcher's consideration to identify the quality of learning set that was compiled. Result of validation showed that the compiled learning set was in good category with minor revision in several parts.

Meanwhile, result of simulation showed that there was a need for minor revision, especially in Lesson Plan 2 along with Student Worksheet 2 and Lesson Plan 3 along with Student Worksheet 3. The revision was associated with observation through laboratory activity for setting tools that made the duration of learning implementation not in accordance with the lesson plan. The final stage of research for the first year was limited testing of learning set. The testing was conducted in one of the State Junior High Schools in Bone Bolango District, Gorontalo Province. The initial test (pretest) was done before test of learning set, and it was to determine the initial skills of students. Meanwhile, the final test (posttest) was done after test of learning set. Also, the testing involved observation on the implementation of lesson plan and student activity.

Average score of the observed aspects for each category on the testing of multiple representation-based integrative science learning set included: Introduction was 3.8 with a very good category, main activity was 3.9 with a very good category, closing was 3.4 with a good category, and classroom atmosphere was 3,6 with a very good category. The result of data analysis also showed that the lesson plan for multiple representation-based integrative science learning was well implemented in limited testing.

Result of observation on student activity indicated that the dominant activity was the activity of observing, experimenting, and working in group and the minimum score of student activity was irrelevant behavior. The average score of student activity for observation was 19.39%, while the less relevant behavior was 4.62%.

Final analysis in the development stage was the analysis of scientific literacy skills and conceptual understanding. Result of the analysis showed that the results of scientific literacy and conceptual understanding of Natural Science increased from the free and posttests. The increase in the score of both scientific literacy and conceptual understanding was indicated by value of gain for 0.42 and 0.53, respectively. Based on the gain category by Hake (Cheng, Thacker, Cardenas, & Crouch, 2004), the values of 0.42 and 0.53 were included in the medium category.

Instead of doing quantitative analysis by calculating the normalized gain value of the scientific literacy score and conceptual understanding of the Natural Science, it was also carried out in a quantitative descriptive to categorize the answer to scientific literacy skills. The quantitative descriptive analysis was carried out by categorizing students' answers based on the scientific literacy answer categories adapted from Soobard & Rannikmäe (2011), which consisted of nominal, functional, conceptual, and multidimensional. From the analysis, the following Figure 1 indicated students' answer categories

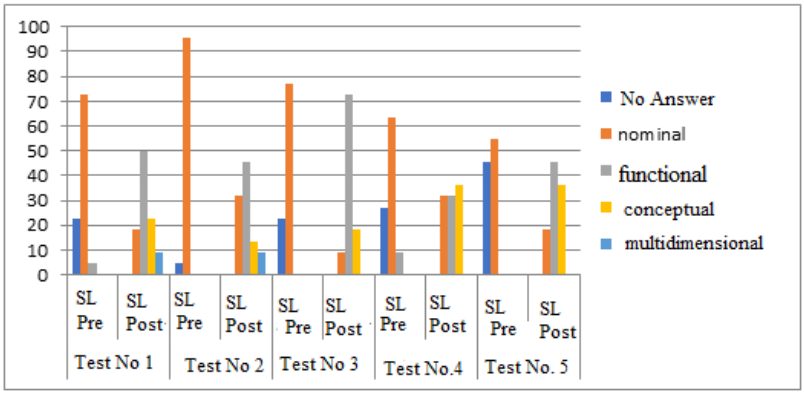

Figure 1. Categories of Answers for Scientific Literacy Test

Figure 1 showed that students' answers on the pretest were included in three nominal, functional, and conceptual categories. Instead of these three categories, some students were unable to provide answers on scientific literacy tests. The percentage of students' answers in the nominal category ranged from 54%-95%, the functional category ranged from 4%-9%, while the other two categories were 0%. The percentage of students who did not answer the initial scientific literacy test ranged from 4% - 45%.

After conducting the multiple representation-based integrative science learning, the results of the students' answers performed better results. In detail, none of the students were unable to answer the scientific literacy test on the final test

(0%). While students' answers were included in the nominal category which ranged from 9%-31%, functional category ranged from 31%-72%, conceptual category ranged from 13%-37%, and the multidimensional category ranged from 0%-10 %.

Conclusion and Recommendation

Based on the research finding and result of data analysis, several conclusions were drawn as follows:

1. The multiple representation-based integrative science learning set comprised lesson plan, student worksheet, student book, and scientific literacy test as well as conceptual understanding test compiled based on the validation results showed good and very good categories of quality.
2. The result of simulation also showed that the multiple representation-based integrative science learning could be implemented in Natural Science learning.
3. The results of limited testing showed that after application of the multiple representation-based integrative science learning, the scientific literacy and conceptual understanding of Natural Science improved. This could be shown by the values of gain values of scientific literacy for 0.42 and 0.53, which were included in the medium category

Suggestion/ Recommendation

Dikomentari [XX4]: Untuk paper prosiding tidak perlu ada bagian suggestion/recomendation

Based on the research finding and data analysis, the following are recommendations.

1. The Natural Science learning in SMP (Junior High School) level should integrate concepts of physics, chemistry, and biology.
2. The integration should be followed by a state where teacher uses multiple representation which cover representations of descriptive (verbal, graphic, and table), experimental, mathematics, and visual.

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A Development of Multiple Representation-Based Integrative Science Learning Set to Improve Scientific Literacy in The Concept of Heat

Abdul Haris Odja
Department of Physics Education, Universitas Negeri Gorontalo
Email: abdulharis@ung.ac.id

Abstract

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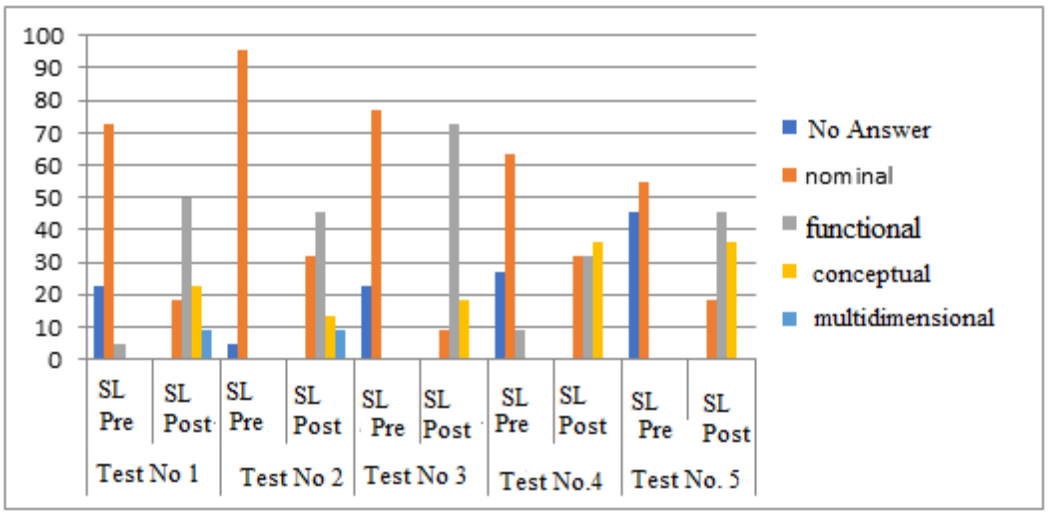

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