The effectiveness of multi modal representation text books to improve student's scientific literacy of senior high school students

Hanifah Zakiya, Parlindungan Sinaga, and Ida Hamidah

Articles you may be interested in

Integrated argument-based inquiry with multiple representation approach to promote scientific argumentation skill
AIP Conference Proceedings **1848**, 050002 (2017); 10.1063/1.4983958

Effect of levels of inquiry model of science teaching on scientific literacy domain attitudes
AIP Conference Proceedings **1848**, 050004 (2017); 10.1063/1.4983960

Developing multiple-choices test items as tools for measuring the scientific-generic skills on solar system
AIP Conference Proceedings **1848**, 050012 (2017); 10.1063/1.4983968

Development and validation of science, technology, engineering and mathematics (STEM) based instructional material
AIP Conference Proceedings **1848**, 060001 (2017); 10.1063/1.4983969

Developing energy and momentum conceptual survey (EMCS) with four-tier diagnostic test items
AIP Conference Proceedings **1848**, 050010 (2017); 10.1063/1.4983966

Implementation of 7e learning cycle model using technology based constructivist teaching (TBCT) approach to improve students' understanding achievment in mechanical wave material
AIP Conference Proceedings **1848**, 050005 (2017); 10.1063/1.4983961

The Effectiveness Of Multi Modal Representation Text Books To Improve Student's Scientific Literacy Of Senior High School Students

Hanifah Zakiya[1,a)], Parlindungan Sinaga[1)] and Ida Hamidah[2)]

[1)]Department of Physics Education, FPMIPA, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
[2.]Departemen of Electronic Engineering Education, FPTK, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung, 40154, Indonesia

[a)]Corresponding author: psinaga@upi.edu

Abstract. The results of field studies showed the ability of science literacy of students was still low. One root of the problem lies in the books used in learning is not oriented toward science literacy component. This study focused on the effectiveness of the use of textbook-oriented provisioning capability science literacy by using multi modal representation. The text books development method used Design Representational Approach Learning to Write (DRALW). Textbook design which was applied to the topic of "Kinetic Theory of Gases" is implemented in XI grade students of high school learning. Effectiveness is determined by consideration of the effect and the normalized percentage gain value, while the hypothesis was tested using Independent T-test. The results showed that the textbooks which were developed using multi-mode representation science can improve the literacy skills of students. Based on the size of the effect size textbooks developed with representation multi modal was found effective in improving students' science literacy skills. The improvement was occurred in all the competence and knowledge of scientific literacy. The hypothesis testing showed that there was a significant difference on the ability of science literacy between class that uses textbooks with multi modal representation and the class that uses the regular textbook used in schools.

INTRODUCTION

In response to the negative impact of rapid progress of science and technology, it is necessary to reform so-called scientific literacy in formal and informal education [1]. Science Literacy is crucial for human being in both national and international levels to face major challenges in providing adequate water and food, controlling diseases, produce enough energy and adapt to climate [2] The importance of science literacy in formal education is reflected at the national level (Indonesia) refers to the national education goals. Those national education goals then realized in units of the curriculum, which is one element of educational resources that contribute significantly to realizing the potential of the process of developing quality of learners [3].

The designed curriculum has a purpose that is consistent with the current science educational purposes, namely to achieve a literate man of science (Scientific Literacy). The importance of Indonesian students' science literacy achievement can be found both in theory and facts on the contents of the existing curriculum. Theoretically, knowledge of which is expected in 2013 includes competency attitudes, knowledge, and skills in an integrated manner. Expected competencies in the curriculum of Indonesia were also developed in developing science literacy capabilities contained in the domain of the *Programme for International Student Assessment* (PISA).

Besides theoretically, concrete proof that Indonesia emphasized the importance of science literacy achievement can be proved through Indonesia's participation in the PISA program to determine the ability of students' science literacy conducted every three years on the PISA participating countries. This means that the Indonesian curriculum strongly emphasizes capacity building for scientific literacy in students.

As a follow-up, ideal conditions expected from the implementation of the curriculum and the development of science in the real literacy skills of Indonesian students have followed the competence held by PISA, PISA study results showed the average score of Indonesian students in PISA on 2000, 2003, 2006, 2009 and 2012 are respectively 393, 395, 395, 383 and 396. This result in lower average scores of international and scientific literacy of students reflects that Indonesia is still very low. Indonesian low scientific literacy of students could be one of the images that science learning in Indonesia in need of repair.

Indonesian student achievement is not encouraging in a report issued a couple of times by PISA is caused partly because the number of materials in the PISA test is not in the Indonesia curriculum[4]. In particular, the causes of Indonesia students' low achievement to be an indicator that science learning is happening in Indonesia have not been giving emphasis on the application in the real world [4].

Many research has been done to improve scientific literacy in the learning process, such as 6E STEM Learning by Design Model about temperatures and changes that could improve the scientific literacy of students [5], used *Reading Infusion* [6] used reading and writing to learn on first task [7], setting actual learning environment [8], applied online argumentation to science phenomena [9] and than used Information and Communication Technologies (ICT) to promote the scientific literacy skill. The previous research focus on learning proses (uses model/ strategy, media/ ICT, learning environment and use online argumentation).

Based on research on scientific literacy abilities discovered constraints and enabling factors in order to improve science literacy. Textbooks with the investigation (inquiry) competency-based scientific literacy were valid and appropriate for use in the learning process of science to improve the scientific literacy of students [10]. One of the best ways to make the learning process as a fun activity is through the use of appropriate textbooks [11]. Thus, the textbook is a supporting factor to improve scientific literacy of students. The analysis result shows that science literacy component is the component most dominating scientific knowledge, and a little part of the book presents an inquiry into the nature of science, science as a way of thinking and the interaction of science and technology and society[12].

Results of the same analysis also found [13] concerning the scope of the category of scientific literacy in high school physics textbook used in Bandung. A total of three physics textbooks sampled in this study, and each provides the scope of the category of scientific literacy different. From the whole textbook analysis, physics textbook contains most of the science knowledge and very few investigations category contains the essence of science, the science category as a way of thinking and interaction categories of science, technology, and society. The data illustrates that the outstanding physics textbook generally emphasizes the collection of scientific knowledge.

According to [14] it occurs due to inadequate use of improvised book learning and the implications on teaching and learning physics at school. According [15]in his research on the analysis of the environmental literacy of students revealed that the use textbooks books based supplements environmental education, advising that the achievement of scientific literacy is necessary to the role of teachers in the use of textbooks in order to stimulate the students' skills in literacy dimension. The designed textbook to improve science literacy [16] in the development of scientific literacy does not mean understanding of scientific phenomena and concepts only. On the contrary, science literacy means the ability to form a collective meaning with visual representations, mathematical relationships, operating manuals or technical and verbal concepts. Reinforced the view of scientific literacy with various modes of representation [17].

There is a growing consensus in the research field of science education that science learning involves the practice of learning representation, to create a process of reasoning, habits of mind, and reasons supporting such practices [18]. Representations can turn abstract concepts into becoming a more concrete description [19]. Representation means representing the same concept in a different format, including verbal, pictures and graphics [20]. Many forms of representation were then called multi representation. Multi representation may provide benefit when a person learns a new complex idea [21]. Representation that is expressed with 'multiple' representations relating to the practice of repetition in presenting the same concept through various forms of modes, such as verbal, graphical and numerical, as well as students explained various concepts together repeatedly [22]. Multi-modes representation refers to the use of science concepts which are linked together with a variety of different modes to explain the discourse of science, representing the scientific reasoning and findings. Furthermore, stated to combine two or more forms of multi representation, known as multi-mode representations to text that is by integrating the mode of representation of verbal (text / narrative) with one or more mode of visual representation [23], so that the cohesive and comprehensive written description in describing a concept or phenomenon is created. Exposure natural phenomenon in explaining a concept is a major component to develop the literacy skills of science[24].

Based on studies using models and strategies in an effort to improve the literacy skills of science, many obstacles and suggestions for future research to improve scientific literacy competence by using a textbook. Furthermore, to

produce a textbook that equip students the literacy skills of science would be in accordance with the components of scientific literacy. Based on the analysis above, it has been found a correlation between multimodal representations with science literacy component, through a cohesive and comprehensive written description in describing a concept or explain a phenomenon [23].

Based on preliminary references and studies that have been carried over, researchers are interested in developing a textbook using multimodal representation. The design-oriented representation multimodal debriefing students' science literacy refers to the framework of PISA in 2015 is based on various natural phenomena in the context of global, national and personal that connects various physical quantities. Thus the problems in this research are:

1. How is the improvement of the students' scientific literacy who receive assisted physics learning using multi modes of representation textbook compared to students who had assisted physics learning using textbook used in schools?
2. How is the effectiveness of multi modes of representation textbook in learning physics that equipping students' science literacy oriented?

EXPERIMENT

Designing textbooks is defined as an activity to create a physics textbook for students of class XI of High School on the topic "Kinetic Theory of Gases". This textbook has undergone various revisions of the results of validation, quality test and understanding test. The design phase of this book is done within four months. The development method used in the development stage is the Representational Design Approach Learning to Write (DRALW) [19]. The steps were included: 1) need identification, 2) formulation the indicators, 3) formulation of the outline and concept map, 4) Designing the discourse of science and multi representation, 5) Designing multimodal representation (integration of science and multi representation, 6) Legibility test by students and quality test by the teachers and experts, 7) Revising textbook draft 1 to 2, 8) implementation/ limited trial.

Implementation of the use of textbooks carried out on the material "Kinetic Theory of Gases" is done in three stages: the initial tests, the learning process and the final test. The first stage is performed by doing the initial test for experiment class and the control class in order to find out the ability of students' science literacy. The second stage is performed by using learning textbook, the experiment classes use multimodal representation textbook and the control classes use the regular textbooks used in schools, both get the same learning through "Reading to Learn' strategy. This strategy was selected to emphasize the influence of book in learning. This strategy is using students' reading sheet. The third stage is conducting the final test to determine changes in the ability of science literacy of students in both classes. The test instrument of the science literacy is using the instrument that has been matched to PISA and Test of Scientific Literacy Skills (TOSLS). The instrument consists of 35 multiple choice questions, the validity of the instrument has the Pearson coefficient Product moment correlation (r_xy) ranges from 0.4 to 08.

The research sample is determined randomly (without random assignment) on XI grade students at one of high school in Baturaja, South Sumatera. The research sample consisted of 70 students of XI grade students which were divided into experimental class and control class. Reading strategy was applied in the learning process of the control class and the experimental class. However, the books used in those classes were different, the experiment class was using the developed textbook and the control class was using regular textbooks used in schools.

Analysis of data to determine the effectiveness of the use of textbook is determined by finding the effect size. The effect size formula used is the formula proposed [25] and the results are interpreted by using the criteria of Cohen [26].In order to determine the improvement of science literacy skills, the normalized gain value is used and then interpreted by using criteria proposed by Hake[27]. Meanwhile, the hypothesis is tested by using "Independent T-Test".

FINDING

The Improvement of Students' Science Literacy

Table 1 showed there is an improvement of students' science literacy in the medium category in classes that used the textbook multimodal representation and lower category in the classes that use regular textbooks used in schools.

TABLE 1. Gain normality of student's Scientific Literacy

Class	Pre-test	Post Test	% N-Gain
Experiment	31,01	57,48	Average
Control	31,75	50,32	Low

The improvement in the Respective Competence and Knowledge of scientific literacy

Table 2 described the increase in students' knowledge type as a result of the use of the multimodal representation textbook. Table 2 showed that the largest gain is in content knowledge and the smallest increase is in procedural knowledge.

TABLE 2. Improved knowledge of each component of students' scientific literacy

No	Knowledge Type	Average Score		
		Initial test	Final test	N gain
1	Content	38,91	65,38	42,18
2	Procedural	25.00	52.94	31.86
3	Epistemic	30,59	56,47	36,76

Beside the knowledge component, an analysis toward the components of scientific literacy competence was also conducted. Description of improvement of each competency is described in Table 3.

TABLE 3. The improvement of each component of competence of students' scientific literacy

No	Science Literacy Competency	Average Score (%)		
		Initial test	Final test	N-gain
1	Explaining phenomena scientifically	38,91	65,38	42,18
2	Evaluating and designing experiments	25,00	52,94	31,86
3	Interpreting data dan scientific evidence	30,59	56,47	36,76

Table 3 respectively describes the increase of the students' scientific literacy's competence as a result of the use of the multimodal representation textbook. In Table 3 are found the greatest improvement in the competency of explaining phenomena scientifically and the smallest increase in the competence of evaluating and designing experiments.

The Effectiveness of Textbook In Improving Students' Science Literacy

The Effect Size of use of Textbook in Improving Students' Science Literacy. It was found that the average increase in the experimental class was 27.47 with a standard deviation of 11.66. It was found that the increase in the average grade control was 19.57 with a standard deviation of 8.73. So that the coefficient of the effect size was d = 0.77. Based on the analysis, it is evident that the use of the multimodal representation textbook is effective to improve the students' science literacy on the topic of "Kinetic Theory of Gases".

Hypothesis testing in order to prove the increase of students' scientific literacy on the topic of Kinetic Theory of Gases, it is necessary to test the hypothesis. The proposed hypothesis (Ho) is that there is no significant difference in the students' scientific literacy on the topic of Kinetic Theory of Gases between the control class and experimental class. Based on different test of two average gain students' scientific literacy in the experimental group and the control group, it can be concluded that there are significant differences in the students' scientific literacy for students who use textbooks using multimodal representation compared to the students' scientific literacy for students who use textbooks commonly used in school.

DISCUSSION

Based on the results of the study in class experiments which is using textbooks that developed by multi modal representation found the value of N-Gain is in the amount of 0.38 that categorized as *medium value*. The result of N-Gain in the control class (using the general textbook) is in amount of 0.27 that categorized as *low value*. This means that textbooks that developed with multi modal representation are further enhance students' science literacy skills compared to the general textbooks (students worksheet) used in schools. Science literacy skills improvement was supported by a development process that considering quality of the book and considering the legibility of textbooks

by students. In other words, the books have been revised repeatedly at the stage of expert validation, quality testing by teachers, quality testing by experts and legibility test paragraph by students. So it can produce a textbook that is easily understood and can enhance students' science literacy skills.

The difference of the study result indicates that textbook which is developed has different characteristics with general textbooks used in schools. The main characteristic that distinguish the result is the integration between the discourse of science and multi-representation (visualization) arranged in a cohesive and comprehensive writing in describing a concept or phenomenon, is called multi modal representation [23]. Theoretically, science literacy is the ability to engage with the issues related to science, and the ideas of science as a reflective citizen [24]. As a result, the involvement of students in scientific issues related to the daily life equally trains the students to science literacy. The scientific issues or discourses used as the main component of the book that is developed.

Practically, the used of scientific issues in textbook has been improved students' science literacy skills. Some examples of scientific discourse is lifted from the phenomenon, technology or scientific issues that can be encountered by students in the daily life, such as the combustion chamber on the vehicle, fumes, dangers of cigarette smoke, use a pressure cooker, and the problem of air bag which expands very fast. The used of the various representation of the scientific discourse is useful to change the abstract concept becomes more concrete description [19].The use of the representation starts from the simple to the complex illustration. For example, the use of verbal representations and images to explain a phenomenon in general (general concept). On figure 1, try to explain the first competency of scientific literacy "Explaining phenomena scientifically" on figure 1, many mode representation for example picture and verbal.
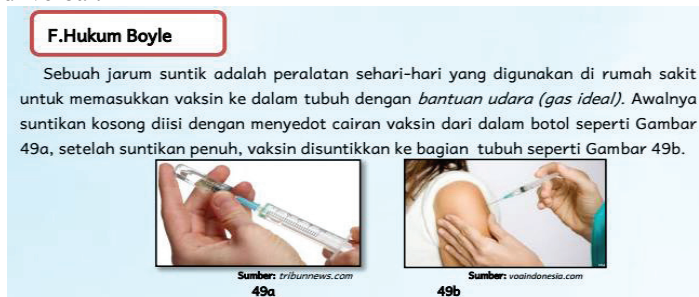

FIGURE 1. Part of book to implemented the first competency of scientific literacy "Explaining phenomena scientifically".

After students understand about the first competency, they can continue to the next competency "Evaluating and designing experiments" student get the phenomena from simple experiment to complicated experiment on figure 2. The data from second competency can be use in third competency "Interpreting data dan scientific evidence". To interpret the data student can use multimode representation to explain the data. However, the student have made their our multimode representation in the end of book, they will be a completion the understanding by another multimode representation.

FIGURE 2. Part of book to implemented the second competency which students can get the data to analyze

There is combination of linguistic and perception or acquisition motivated by the parallel concept through evidence of scientific phenomena causing some of the concepts is based on the perceptual system [28]. Through the scientific discourses / issues, students acquire the concept. Then, the concept is explained by the physical quantities using multi-representation to complete the explanation of the previous representation. The more complex or the more amount of representation is comprehend by the students will increase students' comprehension of a phenomenon or scientific problem. So the students can find a solution in the complexity. The process of finding a solution is one of the processes of giving science literacy skills to the students. This means that the representation is a model or an alternative form of the problem situation or aspects of the situation that is used to find a solution[29].

Multi-representation is very important in research, especially in the field of science education. In science learning involves practices of representation to create a process of reasoning, habits of mind, and reasons for supporting such practices[18]. In that case, multi-representation that combined with the scientific discourse (multi modal representation) is right in theory and implementation in the process of textbook development. Besides the use of multi modal representation, the development of this textbook also considering the character of students. The statements supported [30],who assumed that the effective tools of learning (textbook) should consider the characteristics of the learners. Moreover, stated that there are three sorts of characteristics or circumstances of the students that is important for the teacher to pay attention to; for instance 1) the ability of beginning students. 2) background and social status of the students, 3) personality differences[31].

Developed textbook has been prepared taking into account the diversity of thinking skills and intellectual abilities of students. The ability was considered to present the teaching materials in the form of scientific phenomena (concrete) and then the students are slowly directed to understand the concept (abstract). This is in line with the opinion of Eniayeju [32], which define the textbook as a guide that provide some concrete experiences in which learners need to develop their intelligence. As an illustration, identification of the air is an example of a collection of gas, the air (concrete) we can penetrate it. In other words, between the molecules of the air is making up the gas that are not mutually bound (abstract).

Related to the students' characteristics of the background and social status, this book was developed to be suitable with all background and social status. This is realized by balancing the design scientific discourse, not only in the context of personal but also in local and global contexts. In the personal context, the examples of scientific issues or discourses are given related to the daily life of students of all social status. For instance, the use of gas cylinders, composting, and the breathing process. With regard to the personality of the students, developing students' attitudes through the values contained in the beginning of the book and shapes the attitudes of students to love the environment. For example, avoiding the burning process and awareness of the dangers of smoking, it is associated with attitudes that are expected within the framework of PISA 2015 to improve science literacy.

The ability of science literacy must be implied as the task of a formal or informal science education. It was built as a request for all professionals to be participants in scientific literacy, and as an educator. To make this vision, it needs continuum as a series of unity between formal and informal science education [33]. As shown above, the development of textbooks that have been made can be categorized as an effort to improve the scientific literacy skills, both at the formal (at school) and informal (self-learning activities) education.
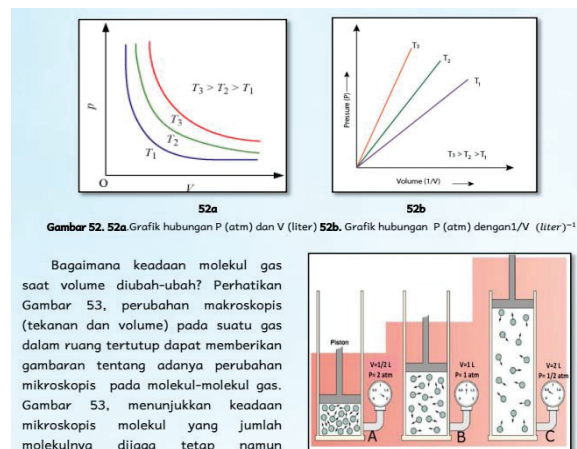

Figure 3. Part of book to completion the understanding by another multimode representation.

Significantly, the capabilities scientific literacy skills in the textbook are integrated not only on teaching materials, but also at the end of sub-chapter exercises. As a consequence, the students expected to read material in school (formal) and the students are also required to do the end of sub-chapter exercises independently (informal).

Some researchers believe that, the book is a source of knowledge, play roles as the major support the independent instruction or teaching program (without teacher) [34]. Furthermore stated that the science textbooks should contain large amount of scientific literacy themes or scientific discourse which is balance and reasonable[34]. Mostly, the content of science depends on an idea of an illustration of the teaching process and effective learning activities. Science content designed both visually and friendly (text) in the textbook. For this reason, the textbook is believed to help students to understanding some difficult concepts and to avoid misunderstandings scientific concepts. Textbooks are expected to increase students' interest in learning science and further contribute to meaningful learning.

In short, the theory that stated by some experts above claimed that textbook support the learning process for students to understand difficult concepts and to avoid misunderstandings scientific. Significantly, the theory that I have mention above proved that textbooks can improve the ability of students to understand the material. Because the book is designed to provide capabilities that oriented to the scientific literacy, there was an increase science literacy skill after the students used this book in learning activities. Based on the analysis, the students' competence and knowledge of science are increasing after the learning process. The greatest improvement of the competence was in the competence#1 "explaining scientific phenomena". According to the [24] competence #1 consists of the activities of identifying, offering and evaluating some natural phenomena and technology. This resulted the high increase in this competency because within each sub-chapter of the textbook presenting scientific phenomena by associating them with concepts that will be studied.

Furthermore, the increase is the lowest competence are competence#2 "evaluating and designing a scientific investigation". According to the OECD 2015 competence#2 consists of the activities of scientific inquiry by proposing ways to apply through scientific inquiry[24]. Hence, the slow growth in the competence #2 is reasonable because only a few activities while implementing investigations conducted since due to the limited laboratory instrument at school. Consequently, the general textbook (Student Worksheet) cannot be implemented. Also, the components of competence and scientific literacy are created based on the three types of knowledge, that are consists of content knowledge, procedural knowledge, and epistemic knowledge. Refer to N-Gain results for each type of knowledge, it can be concluded that the knowledge that the highest improvement was the content knowledge, and the lowest improvement was the procedural knowledge.

The high increase of the content knowledge can be reviewed in the framework of the PISA[24]. Content knowledge has relevance to the real situation, represents an important scientific concepts, and suitable for the growing age level. Based on the framework, the textbook developed has been fulfilled the three indicators that mentioned above. Generally speaking, every part of the book begins from the real world concept (concrete) and every concept has been developed to an appropriate representation. The low increase of the procedural knowledge can be reviewed in the framework of the PISA [24]. Procedural knowledge is relating to the knowledge of standard procedures that used by the scientist in order to obtain reliable and valid data. The low achievement of knowledge caused by the current procedure implementation guide, students simply read the student worksheet without collecting data due to limited laboratory tools. So that students are not trained to obtain quantitative data that is valid and reliable.

CONCLUSION

Textbooks using multimodal representation may improve students' scientific literacy. This textbook is effective in improving students' scientific literacy on the topic "Kinetic Theory of Gases". There is a significant improvement students' scientific literacy to student learning by the textbook use multimodal representation compared to students who is learning by using the regular textbook. The improvement of students' scientific literacy was supported by the integration of science and multi representation discourse in developed textbook.

The implications of these findings are in order to improve students' scientific literacy, they need to provide learning resources such as textbooks that use multimodal representation and textbooks that can be used by students to learn anytime and anywhere. Thus, the teacher or the government needs to pay attention or selecting appropriate textbook used in learning. One thing to consider is the components used multimodal representation. As a follow-up of this study, the textbook using multimodal representation should be developed for other topics.

REFERENCES

1. X. Liu, International Journal of Environmental & Science Education, **4** 301-311(2009)
2. UNEP "*21 Issues for the 21st Century: Result of the UNEP Foresight Process on Emerging Environmental Issues*" (United Nations Environment Programme, Kenya, 2012)
3. Kementerian Pendidikan dan Kebudayaan, "Dokumen Kurikulum 2013",(Kemendikbud, Jakarta, 2012)
4. Balitbang, Depdikbud. Analisis trend kemampuan siswa Indonesia hasil pisa 2000-2009 *in National Conference of PISA-2011* (Depdikbud, Jakarta, 2011)
5. N. Kheroningtias, Permanasari, I. Hamidah, Jurnal Pendidikan IPA Indonesia, JPII **5 (1)** 94-100 (2016)
6. Z. Fang and Y. Wei, The Journal of Educational Research, **103**:262–273 (2010)
7. M. E. Istiqlal, S. Ferani and S. Karim, "Penerapan Strategi Membaca dan Menulis pada Tugas Awal dalam Pembelajaran IPA Bertema Ultrasound untuk Meningkatkan Literasi Fisika Siswa SMP" *in Simposium Nasional Inovasi dan Pembelajaran Sains*. Syposium conference SNIPS. ISBN 978-602-19655-4-2 88 (2013)
8. C. Chang, K.T Yeh and C.Y Lin, Journal of Science Education and Technology **19**, 4, 332-340 (2010)
9. C. Y. Tsai, International Journal of Science Education **37:2**, 321-339 (2015)
10. I. Permatasari, O. Rusilowati, A. Masturi, "Developing Science Learning Materials For Junior High School Based On Way Of Investigating To Improve Scientific Literacy*" in International Conference on Mathematics, Science, and Education*. ICMSE Proceeding (2014)
11. R. A. Adeboyeje and F.O. Afolabi, "Classroom Management" (Ondo: J.A Ife Ohewa Ent. Nig. Ltd, 1991).
12. H. Zakiya, P Sinaga and E. Rohyani, Jurnal.Wahana.Pendidikan.Fisika **1** 3 (2015)
13. I. Sandi and M. Setiawan, "Analisis Buku Ajar Fisika Sma Kelas X Di Kota Bandung Berdasarkan Komponen Literasi Sains" S.Pd Skripsi.Universitas Pendidikan Indonesia, 2013
14. J. K. Aina, Journal of Research and Method in Education, **2** 5 (2013)
15. I. Inayah, "Analisis Literasi Lingkungan Siswa Pada Penggunaan Bahan Ajar Buku Suplemen Berbasis Pendidikan Lingkungan" *in Seminar Nasional Pendidikan IPA*. Prosiding Seminar Nasional Pendidikan IPA FITK (UIN Syarif Hidayatullah Jakarta, 2014).
16. J. Lemke, "The literacies of science". In E.W. Saul (Ed.), Crossing borders in literacy and science instruction Newark: (International Reading Association) pp 33-47 (2004)
17. B. Hand, Gunel, Ulu, M. Cuneyt. Journal Of Research In Science Teaching **46**, 3, Pp. 225–247 (2009)
18. S. P. Norris, L.M.Phillips, *Science Education, **87***, 224-240 (2003).
19. P. Sinaga, A.Suhandi and Liliasari, International Journal of Sciences: Basic and Applied Research **15** 1, pp 80-94 (2014)
20. V. Prain and Waldrip, International Journal of Science.Education, **28**:15, 1843-1866 (2006)
21. S Ainsworth, "*DeFT: A Conceptual Framework or Considering Learning With Multiple Representations*" Learning and Instruction. School of Psychology and Learning Sciences Research Institute (University of Nottingham, 2006) pp 183-198
22. V. Prain and Waldrip, International Journal of Science Education, **28**:15, 1843-1866 (2006)
23. S. Ainsworth, Computer & Education Journal, **33** pp. 131-152 (1999).
24. OECD, *The PISA 2003 Assessment Framework - Mathematics, Reading, Science, and Problem Solving Knowledge and Skills* (Paris: OECD, 2003).
25. R. Coe, "*What is an Effect Size?.A Guide for User*". Draft version (2000)
26. J. Cohen, "*Statistical Power Analysis for Behavioral Sciences*" (Academic Press. NY, 1969)
27. R. R. Hake, "Interactive Engagement Methods In Introductory Mechanics Courses". Department of Physics, Indiana University, Bloomingtoon. [Online] (1998)
28. L. W. Barsalou, W. Simmons and K.A Barbey, Elsevier Science Ltd. All rights reserved **7** (2):84–91(2003)
29. B. Hudiono, "Peran Pembelajaran diskursus multi representasi terhadap pengembangan kemampuan matematika dan daya representasi pada Siswa SLTP", Disertation, Universitas Pendidikan Indonesia 2005
30. Z. Özdilek, M. Özkan, *The Turkish Online Journal of Educational Technology*, **8** 1 9 (2009)
31. Sardiman. "*Interaksi dan Motivasi Belajar Mengajar",* (Rajawali Press Jakarta:,2011)
32. S. Stephen and Abasi, British Journa of Education **3**, 3, pp.27-35 (2015)
33. X. Liu, International Journal of Environmental and Science Education, **4**, No. 3, pp 301-311(2009)
34. L. E. Chiappeta, Journal of Research on Science Teaching. **30**, 7, pp 787-797 (1993)