



SCIENCE TEACHERS' UNDERSTANDING ON SCIENCE LITERACY AND INTEGRATED SCIENCE LEARNING: LESSON FROM TEACHERS TRAINING

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ABSTRACT

One of the weaknesses of secondary science teachers today is the lack of ability to develop integrated science learning. A descriptive study, followed by a developmental research has been done to determine the factors that caused the weakness, and to find the right solution. In addition, this research involving 25 teachers as subject, has also examined how far the treatment was able to overcome the problems. The descriptive research showed that almost all of the teachers were not skillful enough to teach integrated science. This was due to the teachers' background, in which not all of them studied the integrated science education. Most of them came from biology, physics and chemistry education. They have actually attended the training (arranged by a government) on integrated science teaching, but it apparently has not succeeded. The eight steps of learning approach has been developed and implemented along the training were: (1) Building common perception on science literacy; (2) integrated science analysis based on current curriculum and lesson analysis; (3) presentation; (4) designing lesson plan in groups; (5) simulation; (6) designing lesson plan individually; (7) evaluation-reflection; and (8) rewards. After the treatment, the teacher's ability to develop the lesson plans as well as the understanding of integrated science concepts eventually improved much better. Only three teachers have to follow remedial in making lesson plan since they could not meet the requirements.

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Keywords: teachers' skills, integrated science, science literacy

INTRODUCTION

Science literacy is one of the entities that became the goal of science education (Sadler & Zeidler, 2009). Students that have science literacy will be able to actualize their knowledge in problem-solving through critical thinking, accompanied by positive attitudes or values (Holbrook et al., 2003). In addition, science literacy has an important role in decision making on science issues related to social life (Christenson et al., 2013). Some research results elucidated that students have difficulty in using scientific knowledge for

decision-making processes on social issues (Jho et al., 2014; Sadler, 2009; Dawson & Carson, 2016). This condition shows that scientific literacy is not inherent in students so critical thinking skills and reasoning are still weak, especially when responding to issues in daily life.

Program for International Student Assessment (PISA) showed that Indonesia received an average scientific literacy score of 403 with an average score of all 493 participants in 2015 (OECD, 2016). This data can be interpreted that Indonesian students are still weak in mastering good science as a product of knowledge or body of knowledge. Currently, science literacy is an important area studied by researchers in the field

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of science education (Gormally et al., 2009; Setiawan et.al, 2017; Fakhriyah et al., 2017; Africana et al., 2016; Ismail et al., 2016; Widiyanti et al., 2015; Putra et al., 2016; Wijayanti & Basyar, 2016; Khaeroningtyas et al., 2016; Rubini et al., 2016). Rubini et al. (2016) explored students' literacy achievement in rural and urban areas of Bogor-West Java. This study shows that the achievement of science literacy students in Bogor city is quite low, with an average of about 30% for all aspects, consisting of 29% for content, 30% for the process, and 31% for context. Rubini et al. (2016) also state that the science literacy of the teacher still low. The low of students' science literacy is caused by several factors, among others; the low science literacy of science teachers, the difficulties of science teachers in designing an integrated science learning and science learning did not accommodate the nature of science.

Some research has been conducted to develop students' science literacy, such as through a learning process that involves socioscientific issues (Sadler & Zeidler, 2009; Soobard & Rannikmae, 2011). In addition, students' science literacy can also be developed through a learning model based on constructivism (but the improvement of students' science literacy is still in the medium category (Ardianto & Rubini, 2016). These studies showed that the development of students' science literacy is an interesting study for science education practitioners. Therefore, this research tried to

examine the model of training or science professionalism of science teachers based on science literacy. This research was an attempted to answer some research questions as follows: (a) How are the science teacher's perception of science literacy and integrated science learning; (b) how is the model science teacher training based on science literacy; (c) how does the teachers' understanding about the concept of science literacy after training program; (c) how does the teachers' understanding about the concept of integrated science learning and the ability to design integrated science learning?

METHODS

This study was conducted in rural and urban areas of Bogor city, West Java. The subject was 25 science teachers selected under some criteria (undergraduate qualification from chemistry, biology, and physics education background, at least 5 years' experience as a science teacher, and has a science teacher certificate). The teacher profile included: the teacher understand to integrated science concepts, science literacy concepts, and the willingness to implement the integrated science learning based on science literacy. The research stages were composed of teacher perception surveys, training program design, and workshop. Description of the research stages appears in Table 1.

Table 1. The Research Stage

No	Stage	Description
1.	Survey	This stage aimed to explore the perceptions of science teachers about integrated science learning and scientific literacy. Researchers asked the teachers involved in the study to fill out questionnaires about their perceptions of integrated science learning and science literacy
2.	Design of teacher professional development program	In this stage, researchers developed a model for developing teacher professionalism. The process of developing the development program involved 3 researchers and 1 education expert from another university.
3.	Workshop	a. Prior to the workshop, researchers gave a pretest to participants. The pretest is done for 100 minutes. This pretest aimed to assess the teacher's understanding of integrated science learning and science literacy. The pretest was carried out before the implementation of the program. b. The workshop involved 2 experts in science education. They deliver the concept of integrated science learning and science literacy. Furthermore, in this session, the participant worked in groups to develop the design of integrated science learning and science literacy' assessment. The workshop was done in 2 sessions. Each session needed 80 minutes.

c. In the final part of the workshop, researchers gave a posttest to assess participants' understanding of the integrated science learning and science literacy after they conducted the workshop. The posttest lasted for 100 minutes. In addition to assessing the teacher's understanding, researchers also assessed the design of the lesson plan that had been prepared at the workshop stage.

RESULTS & DISCUSSION

The instruments that used in this study were the teacher perception on science literacy questioner (TPSLQ), teacher perception on integrated science learning questionnaire (TPISLQ), comprehension test on integrated science and science literacy concepts, rubrics for teachers' performance (in arranging the science lesson plan). TPSLQ and TPISLQ were used before implementing the program. The results were then used as a baseline for designing the professional teacher development program. The data were then analyzed by using qualitative as well as quantitative ways. The quantitative data analysis was performed on using inferential statistics with software IBM SPSS version-21.

Teachers' Perception on Science Literacy and Integrated Science Learning

Before attending the program, all of the science teachers were asked to fill out the questionnaires related to the understanding of the concept of integration in learning and the concept of science literacy. Teachers' perception used as a reference to develop a teacher training program. The prior information of teachers' perception has an important role in designing the training program. In line with Tapilouw et al. (2017) who stated that the training program of science teachers need to be designed according to teachers' need and prior knowledge. The teacher's understanding of both concepts is shown in Table 2.

Table 2. The Understanding of Science Teachers toward Science Literacy and Integration in Science Learning before the Training Program

No	Question	The percentage of teachers who answered (%)		
		Yes	No	Not sure
Integrated science learning concept				
1	Do you understand what the meaning of integration in science learning is?	4	20	76
2	Do you think that integration in science learning involves combining biological, chemical and physical concepts?	40	0	60
3	Have you ever applied the integrated science learning in accordance with the understanding of the concept that you believe?	12	88	
4	Have you ever attended any training related to Fogarty's integration model?		100	
5	Do you want to teach science in an integrated way?		100	
Science literacy concept				
1	Have you ever read about science literacy	60	40	
2	Do you understand profoundly the science literacy concepts?		92	8
3	Have you ever assessed the students' process skills	100		
4	Do you think the process skills are related only to physical skills?		92	8
5	Do you willing to get more information about science literacy?	100		

Two teachers believed that integrated science means integrating concepts of biology, chemistry, and physics sequentially in learning. During the interview, it revealed that most teachers had also the same perception, but they were not convinced by their thinking; so, they chose 'not sure' as their answer. Almost all teachers claimed to have never implemented the integrated science learning because they had no expertise in all three areas of science and still having difficulty in managing integrated learning. This indicated that the teachers were lack of science concept. This is in line with Fakhriyah et al. (2017) who said that pre-service teachers have difficulties in connecting science concept to other disciplines.

Overall, the key issues that should be the concern of all parties including the science teachers were: (1) the teachers' limited understanding of the integrated learning models; and (2) the committee's lack of encouragement to organize an integrated science learning process. Therefore, it resulted in less motivated teachers to implement learning consistently. It indicated that the implementation of teachers' professional development should involve school leaders. The school leaders should be integrated into the professional development program that conducted. Referring to Whitworth & Chiu (2015), school and district

leaders play a significant role in the implementation of the professional development program.

The Designed Middle Science Teacher Development Program (MSTDP)

Teacher professional development is very important because the quality of science learning depends on the teachers. Osborne & Dillon explained that the experience with no innovation would be sustained unless systematic and ongoing professional development of science teachers was provided to support the changes required in the instruction (Trna et al., 2012). The program was designed to be cyclical and could be completed for 1 semester. The program facilitated the teachers as independent learning. The strategy applied in this program was learning from the lesson (Handayani et al., 2015; Dudley, 2013; Pehmer et al., 2015; Whitworth & Chiu, 2015). Having the assumption that the teachers were independent, so, coaching was carried out by on and off methods. This consideration was taken because the teachers were bound by their duties and obligations at school. Such models were expected to be time-consuming and in line with learning activities at school. The overview of the program is presented in Figure 1.

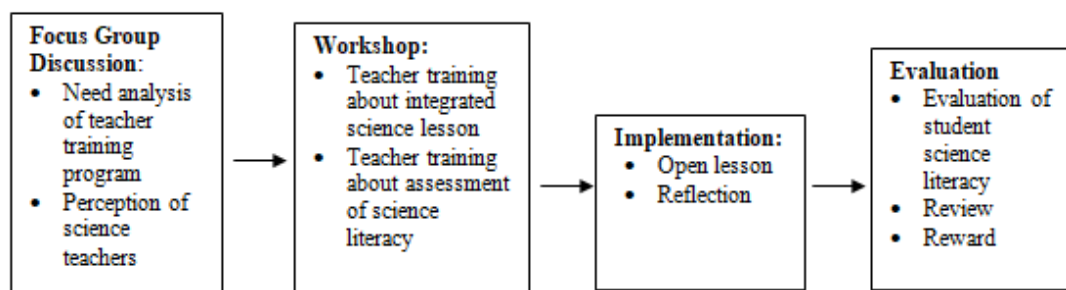


Figure 1. The Model of Teachers Professional Development Program

The program began with the FGD session to have the same perception of the integrated science learning and science literacy concepts. The earned skills were rehearsed during the open lesson and reflection session. The pre and posttest for the integrated science learning and science literacy concepts was done to observe the enhancement of teachers' understand. An assessment of the teacher's ability to design lesson plan was done at the end of the session to ensure that they were able to complete the program.

The Teachers' Understanding on Science Literacy Concept

Science teachers' understanding of the concept of science literacy was assessed by using comprehensive tests. The test was given before and after the teacher followed the training program. The results showed that there was an increase in teacher understanding of the concept of science literacy (as shown in Figure 2.)

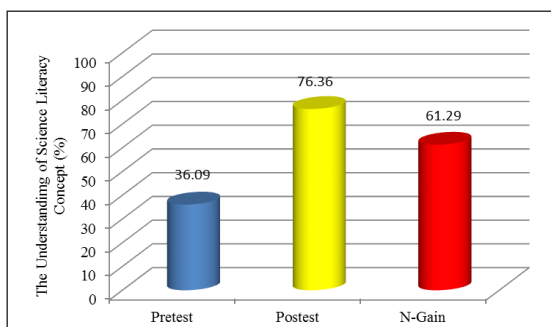


Figure 2. Science Teachers' Understanding about the Concept of Science Literacy

The scores of science teachers' concept mastery on science literacy were then tested using one sample t test. This statistical test was used to find out whether there was a significant difference in teacher understanding about the concept of science literacy before and after training. Statistical test results are shown in Table 3.

Table 3. One Sample T-test Comparing Mean Score Understanding of Science Literacy Concepts between Pretest and Posttest

	N	Mean	SD	P
Pretest	22	36.09	9.98	0.00*
Posttest	22	76.36	5.81	

* < 0.05

Table 3 informs that training programs can significantly increase teacher's insight on the concept of science literacy. The teachers' understanding of the concept of science literacy has increased by 61.29%. The existence of workshop sessions in the training program provided an understanding for teachers about the nature of science literacy and how to actualize it in teaching and learning science. Prior to training, the majority of trainees were not yet aware of the science literacy and how to actualize it. In the workshop session, teachers obtained the materials about concepts, assessment and how to actualize science literacy in a science lesson. This is parallel to Hart & Lee (2010) who stated that teachers could further elaborate and implement science literacy in learning after receiving training programs. As a result, this session provided a meaningful knowledge to the teachers about the concept of science literacy. This is in line with Anwar et al. (2012) who explained that teacher training with workshop sessions could provide an improvement to teachers' insights.

The Teacher' Understanding and Designing of Integrated Science Learning

The teacher's understanding of integrated science learning was assessed by using an essay test. The result of this research showed that before the training program the science teachers' understanding of the concept of integrated science learning was still very low (average 30,23%). Furthermore, after getting the training, the science teachers' understanding increased by 71.55% (as shown in Figure 3).

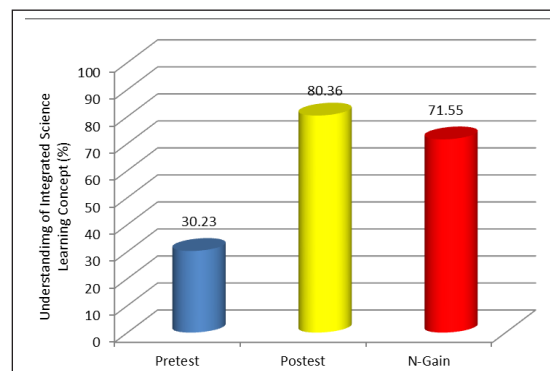


Figure 3. Science Teachers' Understanding of Integrated Science Learning

Table 4 describes that the results of statistical tests on the science teachers' understanding of integrated science learning before and after the training program. The results informed that there was a significant increase in teachers' understanding of integrated science learning (p-value < 0.05) before and after obtaining the training program.

Table 4. One Sample T-test Comparing the Mean Score Understanding of Integrated Science Learning Concepts Between the Pretest And Posttest

	N	Mean	SD	P
Pretest	22	30.22	5.22	0.00*
Posttest	22	80.36	7.75	

* < 0.05

This study also examined the skills of science teachers in designing integrated science learning based on science literacy. Teachers' skills in designing integrated science learning were assessed using teacher performance appraisal rubrics. The skills of teachers in designing integrated science learning are shown in Figure 4. The average score for teachers' skills in designing integrated science learning after training was very high

(the average score of 90). This suggested that training programs have proven to make skilled teachers in designing integrated science learning based on science literacy.

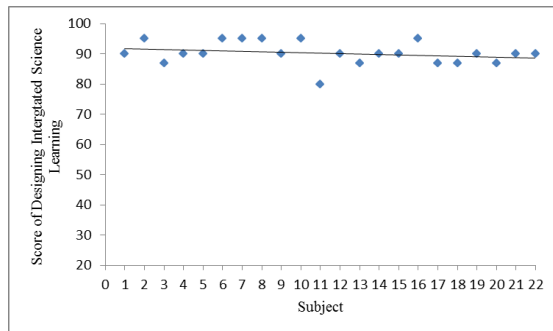


Figure 4. Teachers' Skills in Designing Integrated Science Learning after the Training Program

Based on the analysis of concepts of integrated science learning and lesson plan, the teachers did not only emphasize the integration within the science concepts. The teachers also emphasized the integration of thinking skills, concepts, and attitudes in the designed lessons plan. In addition, the teachers also elaborated the aspects of science literacy (body of knowledge, the way of thinking, the way of investigating and interaction of science, technology, and society) in the design of science learning.

This study showed that teachers made the assessment focusing on the students' science literacy. The evidence suggested that the training process with workshops and self-employment provided a more meaningful experience for the teachers. In addition, the evaluation and reflection sessions assisted the teachers in evaluating lesson plan and assessments. This is parallel to Ekanayake & Wishart (2014) who revealed that the professional development program of teachers with workshop and reflection sessions helps teachers interpret the material provided. Moreover, the training programs involving teachers, stakeholders, researchers, and practitioners of science education help the science community meet the needs of students in learning science and teachers in teaching science. Fradd et al. (2015) elucidated that the collaboration between teachers, researchers, and scientists could help improve the quality of learning in the classroom.

CONCLUSION

This study showed that training programs that covering workshops, self-employment and reflection, and evaluation provided many opportunities to develop teachers' knowledge and skills

in teaching-learning science that is in line with their nature. The collaboration between teachers, stakeholders, researchers, and education experts has helped the science community, teachers, and students improve the quality of science teaching and learning in the classroom. The training program also enhanced the teachers' knowledge of science literacy and integrated science learning concepts, as well as teachers' skills in designing integrated science learning. The teachers' knowledge of integrated science learning and literacy concept is an important asset for improving the quality of teaching and learning in the class. Science teachers' skill in designing lesson activities and assessment, while in fact, there are many teachers lacking this. Therefore, the training program needs to be done sustainably to facilitate science teachers in improving their teaching skills.

REFERENCES

- Afiana, J., Permanasari, A & Fitriani. (2016). A Project Based Learning Integrated To Stem To Enhance Elementary Schools Students Scientific Literacy. *Jurnal Pendidikan IPA Indonesia*, 5(2), 261-267.
- Anwar, Y., Rustaman, N.Y & Widodo, A. (2012). Kemampuan Subject Specific Pedagogy Calon Guru Biologi Peserta Program Pendidikan Profesional Guru (PPG) yang Berlatar Belakang *Basic Sains* Pra dan Post Workshop. *Jurnal pendidikan IPA Indonesia*, 1(2), 157-162.
- Ardianto, D & Rubini, B. (2016). Comparison of Students' Scientific Literacy in Integrated Science Learning Through Model of Guided Discovery and Problem Based Learning. *Jurnal Pendidikan IPA Indonesia*, 5(1), 31-37.
- Christenson, N., Rundgren, S.C., dan Zeidler, D.L. (2013). The Relationship of Discipline Background to Upper Secondary Student's Argumentation on Sosioscientific Issues. *Journal of Research in Science education*, 43(6), 5-12.
- Dawson, V. & Carson, K. (2016). Using Climate Change Scenarios to Assess High School Students' Argumentation Skills. *Research in Science & Technological Education*, 35(1), 1-16.
- Dudley P. (2013). Teacher Learning in Lesson Study: What Interaction-Level Discourse Analysis Revealed about How Teachers Utilised Imagination, Tacit Knowledge of Teaching and Fresh Evidence of Pupils Learning, to Develop Practice Knowledge and so Enhance Their Pupils' Learning. *Teaching and Teacher Education*, 34, 107-121.
- Ekanayake, S.Y & Wishart, J. (2014). Integrating Mobile Phones into Teaching and Learning: A Case Study of Teacher Training through Professional Development Workshops. *British Journal of Educational Technology*, 46(1), 173-189.

- Fakhriyah, F., Masfuah, S., Roysa, M., Rusilowati, A & Rahayu, E. S. (2017). Students Science Literacy in the Aspect of Content Science?. *Jurnal Pendidikan IPA Indonesia*, 6(1), 81-87.
- Fradd, S.H., Lee, O., Sutman, F.X & Saxton, M.K. (2015) Promoting Science Literacy with English Language Learners Through Instructional Materials Development: A Case Study. *Bilingual Research Journal: The Journal of the National Association for Bilingual Education*, 25(4), 479-501.
- Gormally, C., Brickman, P., Hallar, B., & Armstrong, N. (2009). Effects of Inquiry-Based Learning on Students' Science Literacy Skills and Confidence. *International journal for the scholarship of teaching and learning*, 3(2), 16.
- Handayani, R.D., Ryskiadi A., Machrus, A., and Acik, R. (2015). Penerapan Lesson Study untuk Meningkatkan Kemampuan Mengajar Mahasiswa Calon Guru Fisika., *Jurnal Pengajaran MIPA*, 20(1), 27-30.
- Hart, J.E & Lee, O. (2010). Teacher Professional Development to Improve the Science and Literacy Achievement of English Language Learners. *The Journal of the National Association for Bilingual Education*, 27(3), 475-501.
- Holbrook, J., Laius, A., dan Rannikmäe, M. (2003). *The Influence of Social Issue-Based Science Teaching Materials On Students' Creativity*. University of Tartu, Estonian Ministry of Education.
- Ismail, I., Permanasari, A & Setiawan, W. (2016). STEM Virtual Lab : An Alternative Practical Media to Enhance Students Scientific Literacy. *Jurnal Pendidikan IPA Indonesia*, 5(2), 239-246.
- Jho, H., Yoon, H.G. & Kim. K. (2014). The Relationship of Science Knowledge, Attitude and Decision Making on Socio-scientific Issues: The Case Study of Students' Debates on a Nuclear Power Plant in Korea. *Science and Education*, 23, 1131-1151.
- Khaeroningtyas, N., Permanasari, A & Hamidah, I. (2016). Stem Learning in Material of Temperature and Its Change to Improve Scientific Literacy of Junior High School. *Jurnal Pendidikan IPA Indonesia*, 5(1), 94-100.
- Pehmer, A.K., Gröschner, A & Seidel, T. (2015). How Teacher Professional Development Regarding Classroom Dialogue Affects Students' Higher-Order Learning. *Teaching and Teacher Education*, 47, 108-119.
- Putra, M.I.S., Widodo, W & Jatmiko, B. (2016). The Development of Guided Inquiry Science Learning Materials to Improve Science Literacy Skill of Prospective Mi Teachers. *Jurnal Pendidikan IPA Indonesia*, 5(1), 83-93.
- Rubini, B., Ardianto, D., Pursitasari, I.D & Permana, I. (2016). Identify Scientific Literacy from the Science Teachers' Perspective. *Jurnal Pendidikan IPA Indonesia*, 5(2), 299-303.
- Sadler, T.D dan Zeidler, D.L. (2009). Scientific Literacy, PISA, dan Socioscientific Discourse: Assessment for Progressive Aims of Science Education. *Journal of science Teaching*, 1(1), 1-13.
- Sadler, T. D. (2009). Socioscientific Issues in Science Education: Labels, Reasoning, and Transfer. *Cultural Studies of Science Education*, 4(3), 697-703.
- Setiawan, B., Innatesari, D.K., Sabtiawan, W.B & Sudarmin, S. (2017). The Development of Local Wisdom-Based Natural Science Module to Improve Science Literation of Students. *Jurnal Pendidikan IPA Indonesia*, 6(1), 49-54.
- Soobard, R dan Rannikmae, M. (2011). Assessing Student's Level of Scientific Literacy Using Interdisciplinary Scenarios. *Science Education International*, 22(2), 133-144.
- Tapilouw, M. C., Firman, H., Redjeki, S & Chandra, D. T. (2017). The Importance of Training Needs' Questionnaire to Arrange Science Teacher Training Program. *Jurnal Pendidikan IPA Indonesia*, 6(1), 110-115.
- Trna, J., Trnova, E & Sibor, J. (2012). Implementation of Inquiry Based Science Education in Science Teacher Training. *Journal of educational and instructional studies in the world*. 2(4), 199-209.
- Whitworth, B.A & Chiu, J.L. (2015). Professional Development and Teacher Change: The Missing Leadership Link. *Journal Science Teacher Education*, 26, 121-137.
- Widiyanti, F., Indriyanti, D.R & Ngabekti, S. (2015). The Effectiveness of the Application of Scientific Literacy-Based Natural Science Teaching Set toward the Students Learning Activities and Outcomes on the Topic of the Interaction of Living Organism and Environment. *Jurnal Pendidikan IPA Indonesia*, 4(1), 20-24.
- Wijayanti, A & Basyar, M. A. K. (2016). The Development of Thematic Integrated E-Portfolio Media Web Blog Based to Increase the Scientific Literacy of Elementary Teacher Education Programs Student. *Jurnal Pendidikan IPA Indonesia*, 5(2), 284 - 290.