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. Descriptive study, followed by developmental research has been done to determine the factors that caused the weakness, to find the right solution. In addition, the research that involved 25 teachers as subject, has also examined how far the treatment can be able to overcome the problems. The descriptive research shows that almost all of the teachers did not have skillful on how to teach science an integrated way. This is because all of the teacher's background is not from fully 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: (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 eventually improves much better as well as the understanding of integrated science concepts. Only three teachers have to follow remediation in making lesson plan because they still not fulfill a requirement of graduation.

Keywords: teachers' skills, integrated science, science literacy

INTRODUCTION

Science literacy is one of the entity 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 show that students have difficulty in using science 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 of science education

(Gormally et al., 2009; Setiawan et.al, 2017; Fakhriyah et al., 2017; Afriana 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 show 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 process, and 31% for context. Rubini et al. (2016) also state that science literacy of 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 researches have 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 show that the development of students' science literacy is an interesting study for science education practitioners. Therefore, this research will examine the model of training or science professionalism of science teachers based on science literacy. This research will answer about 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 were 25 science teachers those were selected under some criteria (undergraduate qualification from chemistry, biology, and physics education background, at least 5 years' experience as science teacher, and has a science teacher certificate). The teacher profile include: the teacher understand to integrated science concepts, science literacy concepts, and the willingness to implement the integrated science learning based on science literacy. This research stage is composed of teacher perception surveys, training program design, and workshop. Description of the research stages can be seen in Table 1.

Table 1. Research' Stage

No	Stage	Description
1.	Survey	This stage aims 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	• Prior to the workshop, researchers gave pretest to participant. Pretest is done for 100 minutes. This pretest aims to assess the teacher's understanding of integrated science learning and science literacy. Pretest is carried out before the implementation of the program. • Workshop involved 2 expert in science education. They deliver concept of integrated science learning and science literacy. Furthermore, in this session, participant worked in groups to develop design of integrated science learning and science literacy' assessment. Workshop was done in 2 session. Each session needed 80 minutes. • In the final part of the workshop, researchers gave a posttest to assess participants' understanding about integrated science learning and science literacy after they conducted the workshop. Posttest last for 100 minutes. In addition to assessing the teacher's understanding, researchers also assessed the design of lesson plan that had been prepared at the workshop stage.

The instruments that used in this study are teacher perception on science literacy questioner (TPSLQ), teacher perception on integtrated science learning questioner (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 implementation of the program. The result were then used as a baseline for designing the professional teacher development program. Data were then analyzed on using qualitative as well as quantitative ways. Quantitative data analysis was performed on using inferential statistics with software IBM SPSS version-21.

RESULTS & DISCUSSION

1. Teachers' Perception on Science Literacy and Integrated Science Learning

Before attending the program, all of science teachers were asked to fill out questionnaires related to the understanding of the concept of integration in learning and the concept of science literacy. Teachers' perception used as reference to develop teacher training program. The prior information of teachers' perception have important role in designing training program. In line with Tapilouw et al. (2017) which state that training program of science teachers need to be design according to teachers' need and prior knowledge. The teacher's understanding of both concepts is shown by 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 believe that integrated science means integrating concepts of biology, chemistry and physics sequentially in learning. By the interview, it is reveals that most of teacher have also the same perception, but they are not convinced by their thinking so they choose not sure for their answer. Almost all teachers claim to have never implemented the integrated science learning because they have no expertise in all three areas of science and still having difficulty in managing integrated learning. Its mean that teachers' understanding

about science concept still lack. In line with Fakhriyah et al. (2017) which state that preservice teachers have difficulty to connect science concept with other discipline.

Overall, several key issues that should be the concern of all parties, including: science teachers are, teachers' understanding of integrated learning models is still very limited and lack of encouragement from school leaders to organize an integrated science learning process, so it caused less motivating teachers to implement it consistently. Its mean that the implementation of teacher professional development should be involve school leaders. School leader should be integrated into professional development program that conducted. In line with Whitworth & Chiu (2015) which state that school and district leaders play a significant role in the implementation of professional development program.

2. The middle science teacher development program (MSTDP) has been designed

Teacher professional development is very important because quality of science learning depends on the teachers. Osborne & Dillon show that the experience shows no innovation will be sustained unless systematic and ongoing professional development of science teachers is provided to support the changes required in the instruction (Trna et al., 2012). The program is designed to be cyclical, and can be completed for 1 semester. The program fasilitate teachers as independent learning. The strategy that applied in this progam is learning from the lesson (Handayani et al., 2015; Dudley, 2013; Pehmer et al., 2015; Whitworth & Chiu, 2015). With the assumption that teachers are independent, so coaching is done by on and off methods. This consideration is done because the teacher is still bound by his duties and obligations at school. Such models are expected to be time-consuming, and in line with learning activities at school. The overview of program can be shown on Figure 1.

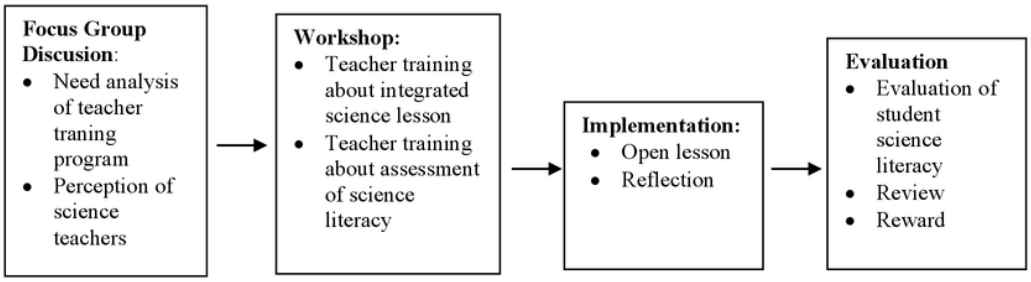

Figure 1. Model Teachers Professional Development Program

The program is started by the FGD session to have the same perception of the integrated science learning and science literacy concepts. The program is by the open lesson and reflection session, on implementing the self-made lesson plan. The pre and posttest for 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 is done at the end of the session to ensure that they are able to complete the program. In this research,

3. The teacher' understanding on science literacy concept

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

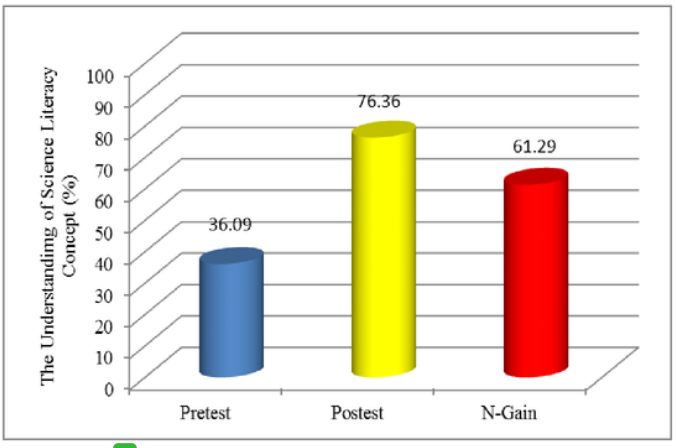

Figure 2. Science teachers' understanding about the concept of science literacy

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

Tabel 3. *One sample t test comparning mean score understanding on science literacy concepts between pretest and postest*

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

*< 0.05

Table 3 shows that training programs can significantly increase teacher's insight about the concept of science literacy. The teachers' understanding about the concept of science literacy has increased by 61.29%. The existence of workshop sessions in the training program provides 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 about the science literacy and how to actualize it. In the workshop session, teachers get material about concepts, assement and how to actualize science literacy in science lesson. In line with Hart & Lee (2010) which states that teachers can further elaborate and implement science literacy in learning after receiving training programs. So that this session provides a meaningful knowledge for teachers about the concept of science literacy. In line with Anwar et al. (2012) which states that teacher training with workshop sessions can provide an improvement to teachers' insights.

4. The teacher' understanding and designing on integrated science learning

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

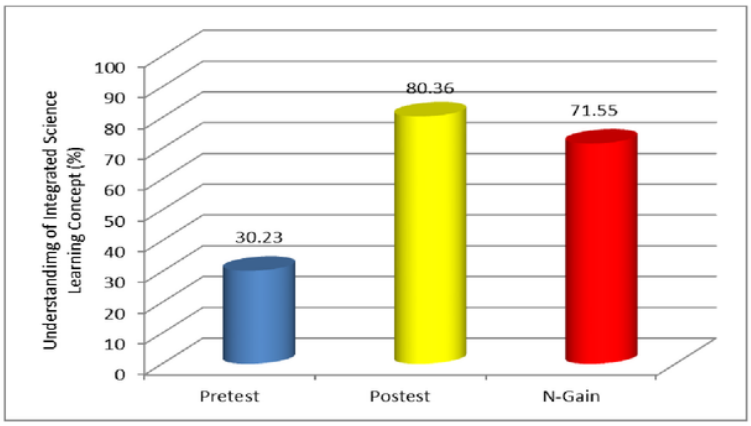

Figure 3. Science teachers' understanding about integrated science learning

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

Tabel 4. *One sample t test comparning mean score understanding on integrated science learning concepts between pretest and postest*

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

*< 0.05

This study also examines the skills of science teachers in designing integrated science learning based on science literacy. Teachers' skills in designing integrated science learning are assessed using teacher performance appraisal rubrics. The skills of teachers in designing integrated science learning are shown in Figure 4. The average score of teachers' skills in designing integrated science learning after training are very high (the average score of 90). This suggests that training programs make teachers more skilled in designing integrated science learning based on science literacy.

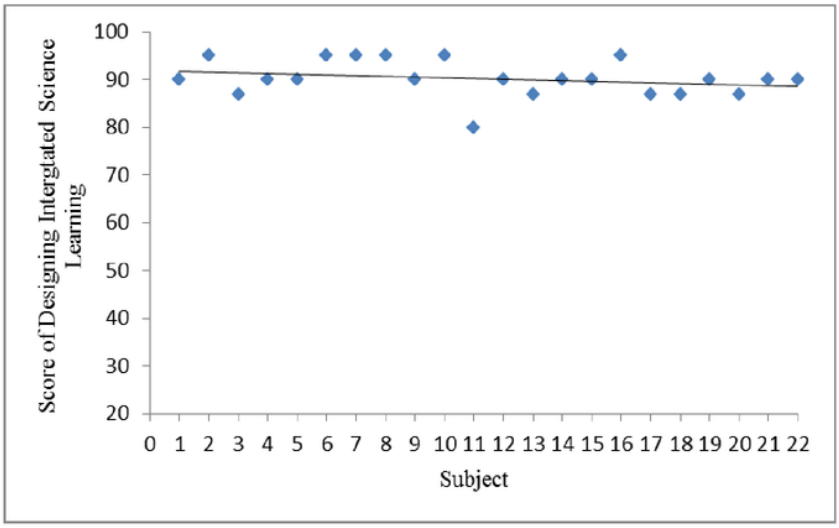

Figure 4. Teachers' skills in designing integrated science learning after training program

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

This study showed that teachers make the assessment that emphasize the students, science literacy. The evidence shows that the training process with workshops and self-

employment provides more meaningful experience for teachers. In addition, the evaluation and reflection sessions assist teachers in evaluating lesson plan and assessments. In line with Ekanayake & Wishart (2014) which revealed that the professional development program of teachers with workshop and reflection sessions helps teachers interpret the material provided. In addition, training programs involving teachers, stakeholders and researchers and practicy of science education enable the science community to help meet the needs of students in learning science and teachers in teaching science. Fradd et al. (2015) tates that collaboration between teachers, researchers, and scientists can help improve the quality of learning in the classroom.

CONCLUSION

This study showed that training programs that use workshops, self-employment and reflection and evaluation provide many opportunities to develop teacher knowledge and teacher skills in teaching and learning science that are in line with their nature. Collaboration between teachers, stakeholders, researchers and education experts makes the formation of a science community that can help teachers and students improve the quality of science teaching and learning in the classroom. The training program also enhances teachers' knowledge of the concept of science literacy and integrated science learning, as well as teachers' skills in designing integrated science learning. The teachers' knowledge of the concept of integrated science learning and literacy as well as the teacher's skills is an important asset for improving the quality of teaching and learning in the class. Science teachers' skill in designing lesson activities and assessment still lack of science context in daily life. Therefore, training program needs to be done sustainably to facilitate science teachers in improving their teaching skills.

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