Professional development model for science teachers based on scientific literacy

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Professional development model for science teachers based on scientific literacy

B. Rubini, D. Ardianto, I.D. Pursitasari, I. Permana

Science Education Study Program, Pakuan University, INDONESIA

Email: bibinrubini@unpak.ac.id

Abstract. Scientific literacy is considered as a benchmark of high and low quality of science education in a country. Teachers as a major component of learning at the forefront of building science literacy skills of students in the class. The primary purpose this study is development science teacher coaching model based on scientific literacy. In this article we describe about teacher science literacy and profile coaching model for science' teachers based on scientific literacy which a part of study conducted in first year. The instrument used in this study consisted of tests, observation sheet, interview guides. The finding showed that problem of low scientific literacy is not only happen the students, but science' teachers which is a major component in the learning process is still not satisfactory. Understanding science teacher is strongly associated with the background disciplinary. Science teacher was still weak when explaining scientific phenomena, mainly related to the material that relates to the concept of environmental. Coaching model generated from this study consisted of 8 stages by assuming the teacher is an independent learner, so the coaching is done with methods on and off, with time off for activities designed more.

1. Introduction

Mastery of Science and Technology is an important key to take on the challenges of the future. These challenges are related to the improvement of life quality, equitable development, and the ability to develop human resources. Therefore, science education as a part of education have an important role to prepare students who have science literacy, which are capable to think critically, creatively, logically, and have initiative to respond the issues in society that caused by the impact of science and technology development (Prayekti, 2006).

Science education is expected to become a vehicle for students to learn about themselves and the environment, as well as prospects for further development to applying it in everyday life (*National Department of Education*, Depdiknas, 2006). Toharudin *et al.,* (2011) argued that science literacy is an ability to understand science, communicate science (oral and written), and also it is knowledge of science to solve problems so the students have attitude and high sensitivity for themselves and their environment in making decisions based on considerations of science.

Developing science literacy is important because: (1) understanding of science offers personal satisfaction and pleasure that comes after understanding and studying nature; (2) everyone needs information and science thinking for decision making in their daily life; (3) everyone needs to use their abilities in public discourse and debate about important issues involving science and technology; and (4) science literacy is important in the world of work, as more and more jobs requiring high skills, thus requiring people to learn science, to reason, to think creatively, make decisions, and solve problems (National Research Council, 1996).

The importance of science literacy has been internationally recognized as the benchmark of high-low quality of education. This is responded by The Program for International Student Assessment (PISA) consisting of highly industrialized countries (*The Organization for Economic Cooperation and Development*, OECD). Results of PISA study in 2000, Indonesian students are in ranks 38th out of 41 countries participating in the science literacy test. In PISA 2003, PISA 2006, PISA 2009, and PISA 2012, Indonesian students' ability still weak on science literacy. The acquiring scores for Indonesian students on science literacy in 2000, 2003, 2006, 2009, 2012 are 393, 395, 393, 383, 382 respectively with an average score of all participating countries is 500 (*Indonesia Research and Development Board*, Balitbang, 2012). According to the analysis by OECD, science literacy scores in the range 335 ≤ 409 points are categorized as level 1 or lower than in the skill category. At this level, students have a limited science knowledge and its only be applied to several situations. Students at this level can only provide an easy science explanation and follows the evidence those were given explicitly (OECD, 2013). Science literacy of Indonesian students should be a concern to all parties. Several things were predicted as a cause of the condition. Low quality and quantity of human resources (teachers and staffs), the quality and quantity of educational facilities, the quality of teaching-learning process are some factors were raised. The results of further analysis of the data PISA for Indonesian students are listed below:

1. Students' literacy achievement is low, with an average 32% for the overall aspect, which consists of 29% content, 34% process, and 32% context applications.
2. Diversity between provinces is not significantly affected on the low level of science literacy learners Indonesia.
3. Diversity between provinces is not significantly affected on the low level of science literacy learners Indonesia.
4. The ability of Indonesian childrens to solve problems is very low.

These findings showed that most of Indonesian students were not able to associate their science knowledge with phenomenon that occur in the world, because they do not have experience to be linked. The comprehensive study on data of *Indonesia Research and Development Board* (Balitbang, 2012) revealed that the achievement of high school students in West Java (grades UN) showed deterioration compared to students of other developed regions such as East Java, Yogyakarta, Jakarta, and Bali. This result indicated that quality of education in West Java needs to be studied, analyzed, and immediately looked for the right solution, so that West Java can be immediately separated from the setback. The achievement setback can be assumed as a weakness in science literacy of students. To solve these problems, such efforts need to be done to rebuild relevance of the educational process with the aim. The other efforts those should be our concern are improving the learning process, strengthening human resources mainly teachers, and improving all the other needs of the educational process.

Study about students' science literacy in Bogor showed that achievement of students' science literacy has not shown satisfactory results. Achievements of students' science literacy is quite low, with an average 30% for the entire aspect, which consists of 29% for content, 30% for the process, and 31% for the context (Rubini & Ardianto, 2014). Rubini & Ardianto advanced idea for measure science literacy of science teacher. This study showed that average scientific literacy teachers was 63% to the overall aspect, which consists of 65% of content, 62% process and 62% applications of science.

Field observations with regard to the implementation of learning science is still dominated by stuffing science concepts to students. Science teachers often complain about classic problem such as lack of time and facilities to carry out science learning by applying science teaching strategies. Scientific practices regarded as additional activities that are allowed to do when they have time. Whereas this strategy that should be applied in science learning. The phenomenon of science teaching such as this will continue if the teacher had always assumed scientific practices in learning is not a requirement that must be met. To solve these problems, need to be made various efforts including rebuilding the relevance of the educational process with the goal. Such efforts can be packed in a pattern of training or coaching science teacher professionalism based scientific literacy.

2. Research Methodology

The primary purpose this study is development science teacher coaching model based on scienctific literacy. In this article we describe about teacher science literacy and profile coaching model for science' teachers based on scientific literacy which a part of study conducted in first year. This study involved 25 science' teachers in Bogor. 23 teachers who follow the teacher qualification test is S1 and the field of educational expertise Physics, Biology or Chemistry. Another science teachers qualified S1 with education background of computer and engineering fields (3 person). Instruments in this study consisted of scientific literacy test adopted from about PISA 2013 and guidelines for teacher interviews were used to explore the weaknesses of teachers in teaching science.

3. Results and Discussion

3.1 Teachers' Science Literacy (Contents Science)

The content aspect on PISA test includes acid rain, greenhouse effect, sport, pollution, cloning, biodiversity, energy, bacteria, photosynthesis, and pesticides. Figure represents the true answer of each item test of Science PISA test based on content.

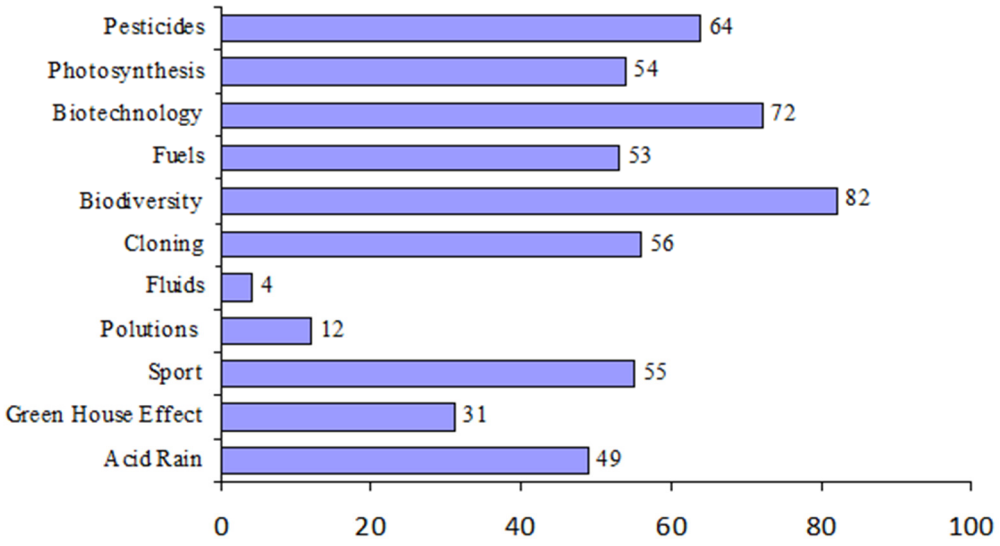

Figure 1. The Precentage of Teachers Achievement in Content Science Test

Figure 1 showed that teachers obtain the highest percentage of correct answers on biodiversity content is 82% and the lowest percentage correct answer on the fluid content (4%). This study proves that the educational background of teachers greatly affect the understanding of contents' science tested. The study involved 23 fields of science teachers with educational expertise Physics, Biology or Chemistry. A total of 15 teachers of them being teachers with educational expertise Biology field. Biodiversity tested more directed at Biology, so the impact on the high percentage of correct answers on this content. Teacher with Biology disciplinary would be easier to answer that question since the conceptual structure has been built up through experience everyday through their teaching activities. Vosniadoun and Ioannides (1998) also argues that the conceptual structure derived from everyday experiences and their constantly restructured to make the existing concept conceptual reached in accordance with the conceptual scientists. The results also showed that when the subjects were given about the material that is not in accordance with his expertise, the percentage of correct answers they were relatively low. This can be seen in the percentage of correct answers on contents fluid only reaches 4%, in other words, only 10 of the study subjects who responded well to the content.

Figure 1 also showed that, teacher's knowledge related to environmental issues is still low. Environmental problems represented by acid rain, pollution and the greenhouse effect. Achievement teacher in this content is still below 50%, meaning that only 12 teachers were able to answer correctly associated contents related to environmental issues. The findings are reinforced by the facts obtained

through interviews with a number of teachers who stated that they were still confused and misconceptions when asked about environmental issues such as global warming, destruction of ozone, acid rain, radioactive pollution and others. The results of this study reinforced by research Spiropoulou *et al*. (2007) which states that 188 teachers in Greece is still limited knowledge when they were asked to discuss environmental issues. Another course of a study also revealed that students and teachers are less understanding about environmental issues and still have alternative conceptions about environmental issues. One of the main difficulties is when explaining the greenhouse effect and global warming (Acikalin, 2013). Some studies also support that position, students (Koulaidis and Christidou, 1999; Rebich and Gautier, 2005) and teacher pre-service (Groves and Pugh, 1999; Kahlid, 2001) still have a conception of the concept of the greenhouse effect.

The results of interviews with a number of teachers found some key issues that should be the concern of all parties, which are; background of qualified teachers is still very special cause difficulties in managing integrated learning. They generally dominate such fields as biology, but not for physics and chemistry. Currently, the government has made electronic school books labeled integrated. However, such alignment is still very little perceived primarily concerned with examples. Generally, teachers are still very low understanding of integrated learning models. Some training integration in science learning have ever they follow, but very few examples given. A lack of motivations from school to organize a unified science learning process, making it less motivating teachers to implement them consistently.

3.2 Profile Coaching Model Based on Science Literacy

Based on discussions with teachers and other stakeholders, and resource persons invited, basically there are some problems that can be addressed through training programs Science teacher in junior high school. The problem identification results are summarized in Table 1 below.

Table 1. Problems and Solutions through Training Programs

No	Problems	Solutions
1	Science teachers have difficulty when constructs integrated science	Training, design, packaging material & discussion integrated science; Surgical junior science curriculum
2	The weakness of teachers in understanding the integration in learning Science	Training, design models of integrated science teaching
3	The need of sharing experience of teachers in teaching science	Lesson activities among science teachers, which implements integrated science teaching Frequency and needs open lesson activities: held at least 4-6 times in one year (2-3 times per semester.
4	The need of teaching materials for the integrated science teaching	Teaching materials are made in groups of teachers Science, the research team made two-three learning package as a model
5	Science teacher rides to gather	Training packaged integrated, involving groups of science teachers, involves a commitment to the school, Head of Education Department (MOU)
6	Training mode typically spend, without a clear product	Mode of training needs to be designed on and off, more off the monitoring of researchers. More open lesson.

The results of the identification of the above problems, as well as various considerations /proposals submitted by FGD participants to complete, then the model is designed with professional training Science teacher in Junior High School as shown by the figure 2. as an outcome in this study.

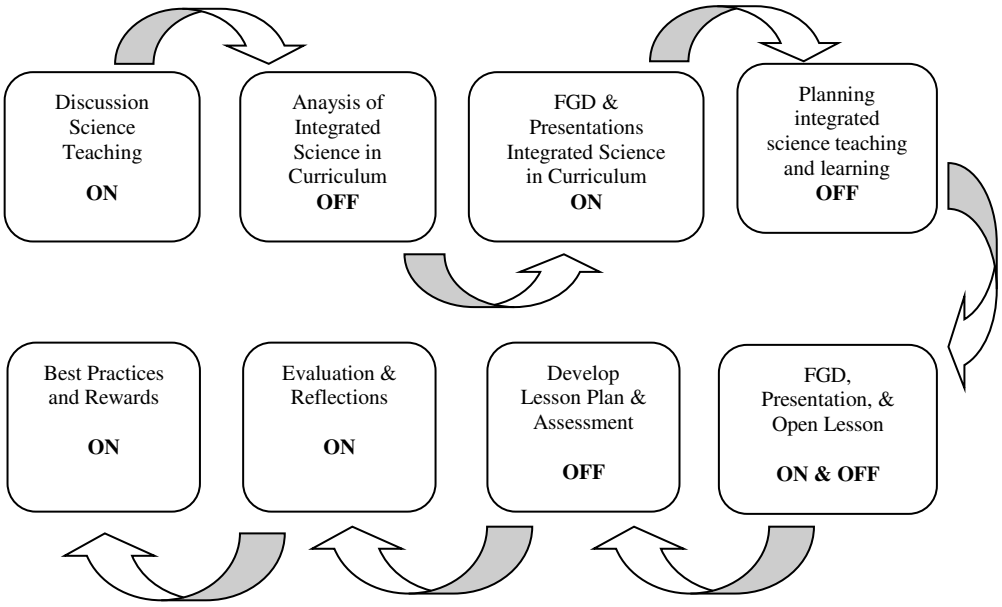

Figure 2. Coaching Model Science' Teachers

Coaching science teacher designed in cycles, and be completed during the first year. Coaching is designed in stages, with the assumption that teachers are independent learners, so the coaching carried with methods on and off, with time off for activities designed more. In addition, these considerations carried remember the teacher still remains bound by its duties and responsibilities in school, so the coaching model as expected not time-consuming, and in line with learning activities in schools.

Phase 1 (ON), in this stage discussions through MGMP, with guest speaker of researchers. The discussion aims to identify perceptions about learning science, including refreshing models of integrated science teaching. Material provided by the research team as a resource. Before, discussions, carried in advance of signing the commitment among teachers and resource persons. Phase 2 (OFF), at this stage the teacher in the group (class) to identify the science content in curriculum that can be taught with the concept of integration. The expectation of this activity is minimal resulting from each class (1, 2 and 3) four (4) integration of science content, so the total is expected to last 12 IPA integration in the content generated through self-employment. Independent work is scheduled for 1 month.

The next stage (Phase 3) is Focused Group Discussion (FGD) held face to face. In this activity, a group of teachers representing the results of an independent study related to integration in science content, which further improved and agreed upon by all participants of FGD. Involving FGD (Research Team). Designed a full day of activities. Once agreed, they then choose one of 12 learning material to be developed in lesson' plan. Selection was based on the possibility activities teaching and learning can be implemented in the month of July (the start of the new school year). Accordingly, this guidance will support real learning in school, and do not interfere with a predetermined schedule school. Phase 4 is carried out independently back. Each group developed a lesson plan with the same theme, complete with an evaluation tool based on its scientific literacy. This stage is carried out with less than 1 month. In addition, each group must make reports including reports for group presentations related to lesson plan have been made.

Phase 5, all the groups presented the results of the working group, giving feedback, and to set the final lesson plan that will be used as the base for an open lesson. In this activity, the group of teachers assign teachers model that will deliver real learning in the classroom. After completion of the planning, implementation of educational / open lesson conducted by the research team facilitator and moderator of school leadership to be a place open lesson. After the open lesson, practices are reflections and suggestions for improvements, and ends with the provision of rewards for teacher's models, as well as an active participant in the discussion. Follow-up of this activity is the distribution of groups/themes for each teacher / group to develop lesson plan (different theme, based on the

themes that have been developed earlier, there are 11 themes). Phase 6, teachers making lesson plans based on the themes that have been agreed (11 theme) in the group. They work independently adjusted with the schedule which they have agreed.

Phase 7, at this stage all the groups presented the lesson plan has been designed, discussions, and provide feedback and improve lesson plans based on the feedback received. All teachers are getting all the lesson plan designed by all the groups, so that they acquire a minimum of 12 lesson plans of 12 science themes that can be taken home). In this activity evaluations carried by both facilitators and peers, giving rewards for the best group also carried out. Furthermore, the agreement for the participant teachers who will implement the model of learning in the open lesson activities (planned there 3 times open lesson on a different theme). The last stage includes activities of the lessons learned with the open lesson of the three themes that have been agreed on stage 7. Open lesson activities carried out on the day / week is different, and ends with reflection, evaluation, and giving rewards.

Basically the coaching model based on the principles of adult learning, more priority to independent work, as well as learning from the experience of teaching (lesson learned). In addition, to ensure that development does not disrupt the rhythm of work of teachers, the administration carried out in the mode "on" and "off". Mode "on" mostly reserved for perception and enhancing the knowledge of teachers, while the "off" is mostly done by the teachers in the group, with the tasks that have been agreed during the "On".

4. Conclusions

This study gives us that the problem of low scientific literacy is not only happen the students, but science' teachers which is a major component in the learning process is still not satisfactory. Understanding science teacher is strongly associated with the background disciplinary. Science teacher was still weak when explaining scientific phenomena, mainly related to the material that relates to the concept of environmental problems. The ability of teachers is very low in the indicator explain scientific phenomena, showing teachers are less accustomed to thinking critically and not accustomed to reason according to their knowledge.

The results also reveal that the problems in the perspective of learning science is a science teacher; 1. The science teacher is difficult to teach Integrated Science; 2. Science Teachers did not understand about integrated science learning models; 3. Motivation science teacher who still lacking in teaching integrated science consistently. Coaching model generated from this study consisted of 8 stages by assuming the teacher is an independent learner, so the coaching is done with methods on and off, with time off for activities designed more. The coaching model based on the principles of adult learning, more priority to independent work, as well as learning from the experience of teaching (lesson learned).

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