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THE DEVELOPMENT OF GUIDED INQUIRY SCIENCE LEARNING MATERIALS TO IMPROVE SCIENCE LITERACY SKILL OF PROSPECTIVE MI TEACHERS

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ABSTRACT

This study aimed to produce valid, practical and effective guided inquiry model science learning materials to enhance science literacy skill of prospective MI teachers. The tryout of the materials was implementedto students of MI teacher educationof Unipdu Jombang at academic year of 2015/2016 semesters 3 using One Group Pretest Posttest Design. The data collections were done using observation, testing, and questionnaires. Data were analysed using descriptive analysis of quantitative, qualitative and non-parametric statistical tests. The findings of the research were: 1) the learning materials were valid; 2) Practicality of the materials was tested through the implementation of lesson plans, while the learners' activity wereappropriate to the guided inquirymodel; and 3) The effectiveness of the learning materials in terms of improvement of learning outcomes of students was seen from the n-gain with high category and increasing mastery of science literacy skills of learners also scored n-gain with high category and the response of students to the device and the implementation of learning is very positive. It was concluded that the materials were valid, practical, and effective to enhance science literacy skills of prospective MI teachers.

Keywords: guided inquiry model, prospective MI teachers, science literacy, science learning materials.

INTRODUCTION

Natural science is the driving force of the development of information and communication technology that has fundamentally changed the human life. In the globalization era, many people's lives are affected by the development of science and technology. Many problems that arise in daily life require scientific information to solve it. Therefore, scientific literacy becomes a necessity for every individual to have a greater opportunity to adjust to the dynamics of life. As the time goes, information and technology keeps developing very rapidly. Everyone should be able to understand the environment, health, economic and other problems faced by modern society. Therefore scientific literacy is a must for everyone. Scientific literacy is very important for a person because of the development level of a nation is determined by the quality of human resources that possess science and technology awareness (Genc, 2015; Jurecki, 2012; Holbrook, 2009; UNESCO, 2008; Turgut, 2007, 2005).Science education is expected to be able toimplant scientific literacy which in turn support Indonesia development. Science literacy has now become widespread concern for scientists, professors and politic's stakeholders (Impey, 2013).

Researches on science literacy skill of learners in an international scale are organized by the Organization for Economic Co-operation and Development (OECD) through the Programme for International Student Assessment (PISA). Scientific literacy is considered as a key in educa-

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tion for all students, whether or not to continue studying science after that (Turiman, et al., 2012; OECD, 2013).

The low scientific literacy level of Indonesia students is a solid proof that science learning in Indonesia still needs improvement. Interpretation can be inferred from the results of the PISA study that what we teach is different from the demands of the mankind. When we observed at the school, studentswere very good at memorizing, but less skilled in applying their knowledge in problem solving. It was probably associated with the tendency to use memorization as a mean for mastering science, not the ability to think. According to Toharuddin (2011), the science educators in Indonesia seemto not yet fully understand well about the learning that leads to conceptual abilities.

Development of scientific literacy of prospective teachers becomes the challenges of teaching and learning in higher education (Murcia, 2009). The results of the survey in 1988-2008 showed that the improvement of scientific literacy of students in American universities was less significant since it was only 10% -15% (Impey, 2013), while scientific literacy of prospective teachers in Turkey was also low (Akengin & Sirin, 2013).

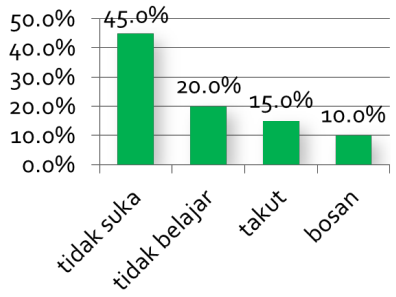

Figure 1. Graphic of Preliminary of the Low Literacy of Prospective elementary teachers.

Results of a preliminary study conducted by researchers at 32 prospective MI (Islamic Elementary School) teachers at a private university in East Java showed a wide range of scientific literacy problems in science lectures. These problems included the heterogeneus educational background; dislikingscience (45%), unwillingness to study science(20%), fearing science(15%) and boring, negative perceptions of students towards science, their low interest in science (10%), resulting in inoptimal learning outcomes and low scientific literacy. These results show the existence of problems in science for prospective MI teachers, regarding with the process and learning outcomes of science. In general, it means that prospective MI teachers have not been able to achieve ideal characteristics of MI teacher, e.g. havingconsistent conceptual, procedural and epistemic knowledge to provide an explanation, evaluation, designingscientific discovery, and interpreting data on the diverse situations of complex life in which all requirehigh level cognitive thinking.

The development of literacy is needed to help prospective teachers to understand the materials and elements of science literacy, as well as being able to use appropriate teaching methods to develop scientific literacy in the classroom (Udompong et al., 2014). In improvingscientific literacy, prospective teachers should be given innovative learning so that the material being taught can be understood meaningfully for everyday life. Holubova (2013) states that all innovative learning methods should be learner-centered (active learning, Problem Based Learning, interdisciplinary relations) aims to improve the knowledge, concepts and skills of prospective teachers.

The science learning should equip prospective teachers with professional knowledge. Professional knowledge includes knowledge of content, pedagogical content knowledge, general pedagogical knowledge, and knowledge of learners and learning (Eggen & Kauchak, 2013). The learning environment and learning readiness also contribute to science learning achievement (Widyaningtyas et al., 2013). Lecturers must pay attention to teaching and learning that focuses on the right concept for students, strengthen their confidence, improving the relationship between the environment contexts with the teaching and learning (Udompong & Wongwanich, 2014). Activities with scientific methods are effective to develop scientific literacy and improve the learning process and success of learners (Toeman & Glucuer, 2012; Lederman, et al., 2013). Doing investigations in the laboratory can also increase scientific literacy and observation skills (Gormally, et al., 2012; Brickman, et al., 2009), and reading habits are elements that improve the scientific capabilities. Improving scientific skills reflect the increase of scientific literacy (Hamza & Ahmet, 2013). Literacy activities through scientific investigation or multiple learning modalities (read it, write it, do it, and talk it) provide support for teaching and learning science through inquiry (Odegaard et al., 2015).

One of the investigation activities in science learning at MI is by guided inquiry learning model. Guided inquiry learning model is an alternative to be developed to elevate science literacy. Guided inquiry learning modelconsists of

six stages (phases): (a) planning, (b) information, (c) processing information, (d) making information, (e) communicating information, and (f) evaluating (Alberta, 2004). Guided inquiry learning allows learners to build knowledge independently and helps them to develop understanding of the concept of representative and exercises their scientific literacy (Pandey, et al., 2011; Stricklyn, 2011; Lee, et al., 2010; Minner, et al ., 2010; Wilson, et al., 2010; David, 2006).

Based on the explanation above, the model of guided inquiry was selected to build science literacy of prospective MI teachers. Researchers designed and conducted research to develop teaching materials with guided inquiry model forimprovingscience literacy of MI teacher candidates. The focus of research concerned with the validity, practicality and effectiveness of the teaching materialswith guided inquiry model to train scientific literacy skill of prospective MI teachers. The research aimed to produce valid, practical, and effective teaching materials with guided inquiry model to instill science literacy skill of prospective MI teachers.

METHOD

This study wasdeveloping science teaching materials with guided inquiry model to develop science literacy skill to prospective MI teachers. The research was carried during September to December 2015. Subjects were 35 learners of PGMI (MI Teacher Education) 3rd semester who took science subject in the academic year of 2015/2016.

The design of the research isOne–Group Pretest Postest design. (Fraenkel, 2012)

Pre - test	Treatment	Post - test
O1	X	O2

Figure 2. One–Group Pretest Postest design

The variables associated with this study are as follows:

1. Guided inquiry learning model
2. Validity of teaching materials
3. Variables related to the practicality of learning tools, including:
   a. Learning implementation
   b. Students' activity
4. Variables related to the effectiveness of learning tools, including:
   a. Improvement of learning result
   b. Science literacy skill
   c. Students' response

RESULT AND DISCUSSION

Educators as innovative agents of change are required to have the ability to guide learners in the activities of scientific investigation (Lu, & Ortlieb, 2009; of Jan, et al., 2001). Educators in science learning ideally have to understand science conceptually and deeply, capable of reasoning qualitatively or quantitatively, able to understand and develop multiple representations, able to develop the skills of scientific literacy, having skill in science inquiry and be able to anticipate the conceptual difficulties experienced by learners (McDermott, et al., 2006; Heron, et al., 2005; Kautz, et al., 2005; and McDermott, 2004).

The learning model of guided inquiry is a learning model that fulfill many curriculum requirements through engagement, motivation, and learning challenging in line with the purpose for the 21st century for educational institutions to guide students to think and learn through inquiry (Madden, 2011; Kuhlthau, et al ., 2012; 2010; 2008; 2007).

Guided inquiry is characterized by identifying problems and some questions by educators as a research procedure and the learners are given clear and concise performance goal for investigation activities (Wenning, 2011; 2010; 2006; 2005). Application of guided inquiry learning does not only improve the ability of students to understand the material but can also enhance science process skills and scientific work (Ambarsari, et al., 2012; Ariesta & Supartono, 2011; Grant, 2011; Khan, et al., 2011).

Guided inquiry learning allows the learners to build knowledge independently and helps learners to develop understanding toward representative concept and develops scientific literacy (Pandey, et al., 2011; Stricklyn, 2011; Lee, et al., 2010; Minner, et al ., 2010; Wilson, et al., 2010; David, 2006).

There are several characteristic of guided inquiry, they are:

1. Learners are conditioned to conduct investigations to gain knowledge.
2. Learners are encouraged to be active and reflected on the learning experience.
3. Students learn based on what they previously know.
4. Learners develop a range of thinking in the learning process through guidance.
5. The development of learners occur gradually.
6. Learners have different ways of learning.
7. Students are educated through social interaction with others.

(Ashiq, et al., 2011; Sadeh & Zion, 2011; Khulthau & Todd, 2008).

Guided inquiry learning offers integrated investigation planned and guided by educators, enabling learners to gain more understanding of the subject content of the curriculum and information concepts. Guided inquiry learning is able to develop the skills and abilities necessary for work and daily life in the 21st century (Gerald, 2011; Opara & Oguzor, 2011; Rust, 2011).

In brief, guided inquiry learning model has several advantages:

1. Increase learners' motivation.
2. Provide opportunities for learners to think further about ideas, problems, and questions.
3. Provide opportunities for learners to fully participate fully in the thing that will increase their curiosity, both inside and outside the classroom.
4. Encourage learners to have a initiative spirit.
5. Encourage patience, cooperation, unity, and decision-making between learners.
6. Improve students' understanding of the processes, concepts, and its relationships.
7. Providing education and knowledge that allow them to explore the social environment.

(NRC, 2011; Berg, *et al.*, 2003; Crawford, 2000; Crockett, 2000; Luft, 2001)

Guided inquiry learning model also has obstaclein which learners sometimes feel frustrated if they do not find the ideas (Belland, 2012; Krischner 2006; Fellenz, 2004). Guided inquiry learning model aims to give chance for learners to learn how to find the facts, concepts, and principles through direct experience, to improve science literacy and to train learners in investigating problems or questions.

Guided inquiry learning model is defined as an inquiry learning which presenting problems, questions and supporting material or materials specified by educators. Problems and questions from educators are meant to encourage students to conduct an investigation to determine the answer (Acevedo, et al., 2010; Bao, et al., 2009; Mercer, et al., 2004). Syntax guided inquiry learning has six phases (Alberta, 2004).

Guided inquiry learning model has a good and productive learning environment which the learners are actively trying to find and implement the processes of inquiry, and the role of educator is to guide learners inexperiment.

Management of guided inquiry learning is done in which students are grouped into several teams to be given the task of inquiry to conduct experiments and work well in a group, where educators will consistently guide the learning process undertaken by learners.

Summary data on the students' response to learning in the tryout can be seen in Table 2.

Table 1. Syntax guided inquiry learning

Phase	Explanation
1. *Planning*	Educator presents problems related to everyday life. Educators determine the procedure to solve the problem that will be done by students through experiments.
2. *Retrieving*	Learners find and collect data about the problems proposed educators from various sources.
3. *Processing*	Learners test and prove the hypothesis by conducting experiments and analysing his observations.
4. *Creating*	Learners make decisions and conclusions from his observations, then creating experiments reports.
5. *Sharing*	Learners present their observations. Educators comment on the discussions and provide reinforcement and straightenany mistakes.
6. *Evaluating*	Evaluating(Evaluate)Educators award each of the groups who have made presentations and then they provide authentic individual tasks regarding with the materials that have been studied.

(Source: Alberta, 2004)

Table 2. Students' response

No	Components	Students' response	
		Average score	Criteria
1	*Attention*	4.20	Good
2	*Relevance*	3.80	Good
3	*Confidence*	4.00	Good
4	*Satisfaction*	3.95	Good

Table 2 states the response of students to guided inquiry learning is positive based on

Table 3. Science Literacy Skill Rubric

No	Science Literacy Skill	Level
1	Learners can describe and apply the inquiry inquiry scientific method in investigation, questioning, and solving problems.	**Beginner** a. Students cannot identify scientific problem. b. Students do not understand the problem solving. c. Students cannot identify hypothesis. **Middle** a. Students can identify scientific problem. b. Students choose a solution for problem. c. Students can define hypothesis. **Advanced** a. Students can repeat research questions. b. Students can predict one or more solutions. c. Students can construct hypothesis. **Expert** a. Students can develop research questions. b. Students can evaluate various alternative solutions. c. Students can propose how to evaluate hypothesis correctly.
2	Learners can describe procedures and experiment steps	**Beginner** a. Students cannot understand research purpose. b. Students cannot decide the materials for experiment. c. Students cannot interpret experiment variables. **Middle** a. Students cannot rephrase the research purposes with their words. b. Students can designate the materials for experiment. c. Students can differentiate free and bound variables. **Advance** a. Students can rephrase the research purposes with their words. b. Students can designate the materials for experiment. c. Students can differentiate control and free variables. d. Students can explain the relation between steps in experiment. **Expert** a. Students can rephrase the research purposes with their words. b. Students can designate the materials for experiment. c. Students can filter free and control variables. d. Students can manipulate free and control variables. e. Students can modify the research design.

Table 3. Continue

No	Science Literacy Skill	Level
3	Students can present practicum assignment correctly and accurately	**Beginner** a. Students cannot obey safety rules and use lab tools safely and carefully. b. Students cannot follow the writing procedure c. Students cannot identify scientific tools accurately d. Students cannot work independently. **Middle** a. Students obey safety rules and use lab tools safely and carefully. b. Students follow the writing procedure accurately. c. Students can use scientific tools with accurate techniques. d. Students can measure and write the data. **Advance** a. Students obey safety rules and use lab tools safely and carefully. b. Students follow the writing procedure accurately c. Students can use scientific tools with accurate techniques. d. Students can measure and write the data with minimum mistakes. **Expert** a. Students take initiative to follow research procedures accurately. b. Students take initiative to follow writing procedures accurately. c. Students take initiative to use scientific tools with accurate techniques. d. Students take initiative to measure and write the data accurately.
4	Students can interpret and communicate scientific information using writing, verbal and graphic data.	**Beginner** a. Students cannot interpret information quantitatively from the table and graphic using simple vocabularies. **Middle** a. Students can interpret information quantitatively from the table and graphic using simple vocabularies. b. Students can construct table data and present information in graphic. **Advance** a. Students can interpret information quantitatively from the table and graphic using simple vocabularies. b. Students can construct table data and present information in graphic independently. c. Students can communicate experiment and investigation results. **Expert** a. Students can accurately interpret information quantitatively from the table and graphic using sophisticated diction, and make accurate inferences. b. Students can construct table data and present the information in graphic independently. c. Students csn communicate experiment and investigation results clearly. d. Students can draw logic conclusions based on the accumulated data.

Table 3. Continue

No	Science Literacy Skill	Level
5	Learners can describe and analyze one or more relationship issues of science technology and society as well as demonstrating a scientific understanding of the application in daily life.	**Beginner** a. Students cannot identify technology breakthrough and its relationship with science. **Middle** a. Students can identify technology breakthrough and its relationship with science. b. Students can put the technology breakthrough in historical context. c. Students can mention some effects of technology toward society. **Advance** a. Students can identify technology breakthrough and its relationship with science. b. Students can put the technology breakthrough in historical context. c. Students can mention some effects of technology toward society. d. Students can explain one or more scientific technology principals. **Expert** a. Students can identify technology breakthrough and its relationship with science. b. Students can put the technology breakthrough in historical context. c. Students can mention some effects of technology toward society. d. Students can explain one or more scientific technology principals. e. Students can describe some examples or future development of scientific technology in society
6	Learners can show the explanation of natural phenomena with a logical understanding, experiment steps or applying the concept of science and technology	**Beginner** a. Students can hardly identify logical explanation based on observation toward science phenomena. **Middle** a. Students can identify logical explanation based on observation toward science phenomena. b. Students can identify mindset error or illogical explanation based on observation. **Advance** a. Students can identify several alternative logical explanations based on observation toward science phenomena. b. Students can identify mindset error or illogical explanation based on observation. **Expert** a. Students can identify several alternative logical explanations based on observation toward science phenomena. b. Students can identify mindset error or illogical explanation based on observation. c. Students can evaluate some statements based on observation, experiment, or accumulated data.

(Adapted fromOECD, 2013; Gormally, 2012)

the average score of each of the conditions that support student learning interest with the criteria of very good. Likewise with the average score of each condition for student motivation is onvery good criteria.

Table 3 shows that there are 6 skills of scientific literacy which have multiple levels that have been developed by the researchers based on (OECD, 2013) that the skills of scientific literacy will be owned by a person in different levels after varied learning process depending on the previous understanding, the current understanding of the learning process and the ability of learners in associating their understanding with the concept or other situations.

Some of the findings in this study were based on results and strengthened byfacts during the learning. The findings in this study are as follows:

1. The validity of the developed learning tools can be seen from the results of the validity of the RPP, Student Worksheet, teaching materials, assessment instruments of students' learning outcomes (student attitude assessment instruments, testt instruments of knowledge aspect, the performance test instrument), and scientific literacy skill test instrument.The guided inquiry model of science learning for enhancing science literacy skill was declared valid.
2. Practicality of science teachingmaterials developed through the implementation in tryout 1can be seen from:

a. The implementation of lesson plan in MI teacher educationsemester 3 Unipdu Jombang in the learning process with two replicates in overall average scored 3.70 categorized in good.
b. Student activities at tryout stage were appropriate with guided inquiry model. In observations, the prominent activity were to design, conduct experiments, and analyse experimental results.

3. The effectiveness of the science materials through the implementation on trial I can be viewed from:

a. Application of the developed guided inquiry model of science materialcould improve students' learning outcomes: 1) the average n-gain of knowledge aspectof 0.88 belonged to high category, 2) the average n-gain ofscientific processingskill of 0.75 belonged to high category and the average n-gain of psychomotor skill of 0.82 belongedto high category and 3) achievement of attitude aspect reached good category.
b. Implementation of the developedphysics learning materialswith guided inquiry model can improvescience literacy skill of prospective MI teachers. The increase of science literacy skills of prospective MI teachers could be seen from n-gain of the semester 3 obtained score of 0.85 with the high category.
c. Students' responses were very positive toward the implementation of science learning with guided inquiry model. The analysis of students' response data were: Attention4.20, Relevance 3.80, Confidence 4.00, Satisfaction 3.95 and all belonged to good categorized.

4. The obstacles were: some students who had low academic plus low literacy skillsand students were still not yet familiar to guided inquiry learning model that mainly uses scientific processing skill and psychomotor in lab.

CONCLUSION

The results of this study indicated that the guided inquiry science learning materials were valid, practical, and effective to enhance science literacy skills of prospective MI teachers.

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