SCIENCE TEACHING AND LEARNING ACTIVITIES AT JINCHENG JUNIOR HIGH SCHOOL TO SUPPORT STUDENTS' SCIENTIFIC LITERACY

A final project

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in Biology Education Study Program

by

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PERNYATAAN

Saya menyatakan dengan sebenar-benarnya bahwa skripsi saya yang berjudul "**Science Teaching and Learning Activities at Jincheng Junior High School to Support Students' Scientific Literacy**" disusun berdasarkan hasil penelitian saya dengan arahan dosen pembimbing. Sumber informasi atau kutipan yang berasal atau dikutip dari karya yang diterbitkan telah disebutkan dalam teks dan dicantumkan dalam Daftar Pustaka di bagian akhir skripsi ini. Skripsi ini belum pernah diajukan untuk memperoleh gelar dalam program sejenis di perguruan tinggi manapun.

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APPROVAL

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MOTTO AND DEDICATION

MOTTO

True teaching is not an accumulation of knowledge; it is an awaking of competence, consciousness, and compassion which goes through successive stages.

A true science learner is a responsible and literated citizen.

DEDICATION

To biology teachers, particularly in Indonesia.

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ABSTRACT

Kusumaningtyas, C.S. 2019. *Science Teaching and Learning Activities at Jincheng Junior High School to Support Students' Scientific Literacy*. A final project, Biology Department Faculty of Science and Mathematics Universitas Negeri Semarang. Supervisor, Drs. Krispinus Kedati Pukan, M.Si.

Keywords: learning activities, scientific literacy, teaching activities

Scientific literacy is an ability to integrate science knowledge with relevant context and encourage people to behave scientifically. This case study describes the teaching and learning activities at Jincheng Junior High School, Tainan, Taiwan in supporting students' scientific literacy. This study was a qualitative descriptive study that describes teaching and learning activities in supporting students' scientific literacy as written in the narrative text. The data was collected by using observation, interview, and documentation. The data was then analyzed through five stages of qualitative data analyses by Nowell *et al.* (2017). The result shows that there were some key activities conducted at Jincheng Junior High involving laboratory, teaching, assessing, and learning activities. The key activities are (1) giving students rooms to investigate and satisfy their curiosity in lab activities, (2) using pictures, tables, and graphs, (3) contextual world, (4) providing students with science discourse, and (5) curious students. There were also some inquiries found: (1) competent teachers that can provide students with tables and graphs and also encourage students to ask; (2) hard working students, will work together to support students' scientific literacy. However, there were some limitations of the frequency of conducting laboratory activities and developing students' inquiry. It can be concluded that teaching and learning activities at Jincheng Junior High School could support students' scientific literacy.

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CHAPTER 1

INTRODUCTION

1.1. Background Study

Scientific literacy is an ability expected from citizens in well developed countries. It is crucial for their science and technology development. One of the tests that can measure it is PISA assessment. In PISA assessment, the test questions offered are mostly linking scientific knowledge with its application in everyday life. The type of test questions are correlated in accordance with scientific literacy as seen in its definition. Based on many definitions on scientific literacy, there are three main ideas to picture scientific literacy, they are knowledge, context, and behavior. Scientific literacy focus on how knowledge is being applied to certain condition to take some actions and decisions toward the recent phenomenon (Dragos & Mih 2015).

Taiwan is a country with well – developed education. Taiwan ranked 4 in Programme for International Student Assessment (PISA) 2015. It was scored 532 in science, from 493 score average. The reason behind its good rank is their education goal. As written in the First National Science Education Conference (2002), Taiwan goal is enabling their citizens to take delight in learning science and understand its application, also be curious about the profoundness of science, and appreciate the beauty of science.

In Taiwan, science education is needed to develop the citizens' scientific literacy in order to enhance its industry. Scientific literacy is their foundation to develop technology as their main focus of industry. Otherwise, technology is incorporated in teaching and learning activities. The driven-technology class is important to support the enhancement towards becoming industrial country. Besides,

Taiwan science education is rooted from everyday life events. In its teaching and learning activities, teachers integrate everyday life issues with the lesson.

One of the schools in Taiwan is Jincheng Junior High School (Jincheng JHS). The school has good facility to support its teaching and learning activities. Their science teaching and learning is divided into 3 grades. For grade 7, students learn biology. On grade 8, they learn physics. On grade 9, they learn chemistry and reviews of biology and physics also to prepare their final examinations.

Satisfying result of PISA test in Taiwan makes it important to explore its science teaching and learning activities. From this background, it emerges a question of how does Jincheng Junior High School teaching and learning activities in supporting students' scientific literacy?

1.2. Research Question

Based on the background study, the research question was how does Jincheng Junior High School support their students' scientific literacy as seen in teaching and learning activities? In detail, the research questioned was listed as follows:

1. What do science teachers teach in class and laboratory to support scientific literacy?
2. How do teachers teach in class and laboratory to support scientific literacy?
3. How do teachers assess if their students are already scientifically literate?
4. How do students learn to be scientifically literate?

1.3. Purpose of the Study

This study aimed to describe Jincheng Junior High School science teaching and learning activities in supporting students' scientific literacy as investigated as its lesson content, the method of teaching, the assessment process, and the learning process students performing.

1.4. Significance of the Study

1.4.1. Theoretical Significance

All findings still support some fundamental theories of science teaching, such as scientific approaches are the only best methods expected to provide students with real rich phenomena, learning science by doing, constructivism and the end goal science teaching is literacy. Science is everyday life (correspondent benefits). This study also underline the hypothesis, if students are more involved in scientific approaches, they better learn science (coherent benefits).

1.4.2. Practical Significance

This study would enrich the availability of alternative assessment, lesson plan and teaching materials, in relation to scientific literacy. This would provide pre–service science teachers and science teachers better understanding of how science teaching and learning should be managed to support scientific literacy and there would be a lesson learned of how to manage science teaching and learning in Indonesia from this study.

1.5. Key terms

Key terms was aimed to avoid misunderstood and clarify the meaning of the research entitled “Jincheng Junior High School Learning Activities and Assessment to Promote Scientific Literacy”.

1.5.1. Science Teaching and Learning Activities

Teaching and learning activities are the process happening in class. It involves teacher and students. The methodology of the activities are provided by the teacher. The methodology is used to deliver the content and skills that the students need to obtain. The activities also included assessment. Teachers need to have a reflection if their lessons are already succeed. Besides, assessment is not only of learning, but also for learning and as learning. Assessment of learning is about grading and reporting, while assessment for and as learning are intended to make assessment a part of teaching to support learning (Earl, 2013).

In teaching science, teachers should set high learning expectations, focus on core scientific ideas, and aim for deep, integrated understanding of scientific inquiry and the core of scientific knowledge. For doing so, teachers must understand how students actively construct new knowledge, students' interests and students' potential conflict with science concepts (Staver, 2007).

This research was limited on the biology teaching and learning activities. It is due to the separation of science teaching and learning in Jincheng JHS. Meanwhile, biology class in Jincheng JHS is only for grade 7.

1.5.2. Scientific Literacy

Scientific literacy focus on students to implement their knowledge in certain condition or context that is happening around them. It is necessary to drive their behavior or attitude in making decision of a problem in their daily life. Knowledge base is very important to each student to make any decision of their life (Roberts & Bybee, 2018: 545–558).

Scientific literacy is learning how science fits with personal and societal perspectives for complete grasp of the issues. It illuminates interaction of science with many areas of human endeavor and life situations (Roberts & Bybee, 2018: 545–558). Then it is operationally defined as students' ability in correlating knowledge with phenomena around them to behave scientifically, that could also be pictured from PISA's score tests.

CHAPTER 2
LITHERATURES REVIEW

2.1. Science Education in Taiwan

Taiwan formularized their science education goal as something as important as their economy growth. As written in the First National Science Education Conference (2002), Taiwan science education is enabling each citizen to take delight in learning science and know the application of science, be curious about the profoundness of science and can appreciate the beauty of science. Since 2002, it looks like that scientific literacy has already been Taiwan's government concern. In their science education goal, there are 3 components as well as in scientific literacy, they are learning science refers to knowledge, application of science refers to context, and be curious and appreciate refer to attitude.

Education is used by Taiwan government to drive its economic growth and sustainable development through citizens' scientific literacy. It plays vital role in driving their country from an agricultural country into an industrial country. Taiwan science education applies some approaches that picture their development. Those approaches are Science, Technology, Engineering, Mathematics (STEM), constructivist approach, learner – centered approach, and inquiry approach. The approaches that is used is aimed to develop competencies in scientific literacy. Those approaches contain lessons that rooted from problems and facts in everyday life.

In Taiwan, their government pay more attention to the pre – service teachers. Before they become a teacher, they have 1 year full of pre – service. At that period of time, the pre-service teachers observe on what the senior teachers do at class, the way they teach and assess their students. A previous research also assess the scientific literacy of pre – service teachers. There are 4 domains that being tested: (1) science content, (2) interaction between science, technology, and society (STS), (3) nature of

science, and (4) attitudes toward science. From the result, scientific literacy level of pre-service teachers is satisfying (Chin, 2005: 1549-1570).

2.2. Scientific Literacy

Scientific literacy relates to the 21st century education and skills. It improves the 4Cs competencies that must be presented in each student: critical thinking, collaboration, communication, and creativity. Scientific literacy demands critical thinking and creativity as well. Scientific literacy emphasizes scientific ways of knowing and the process of thinking critically and creatively about the natural world (Maienschein, 1998: 917). It helps human in any professions to make decision and why they decide to do that. Scientific method is used to finally make the decisions so that all things become logic and objective. Science processes is carried out by human. If there is any controversy about science in social life, people with satisfactory level of scientific literacy can explain their reasons from their critical thinking.

In scientific literacy, literacy is within science, it expresses through the language, product, processes and traditions of science familiarity and fluency. There are several characteristics of scientifically literate person that able to (1) explain phenomena scientifically, means that students must be able to recognize, offer, and evaluate explanations; (2) evaluate and design scientific inquiry, means that students must be able to describe, offer ways to address scientific questions, and assess scientific investigations; and (3) interpret data and evidence scientifically (OECD, 2016:23).

Scientific literacy is learning how science fits with personal and societal perspectives for complete grasp of the issues. It illuminates interaction of science with many areas of human endeavor and life situations (Roberts & Bybee, 2018: 545–558). Scientific literacy can also be defined as a level of science public understanding that encourages one to act in concert with scientific consensus (Crowell &Schunn, 2014: 718–733). PISA (2015) strengthen the importance of scientific literacy by stating that scientific literacy is the ability to understand the characteristics of science

and its significance in modern world, to apply scientific knowledge, identify issues, describe scientific phenomena, draw conclusions based on evidence, and the willingness to reflect on and engage with scientific ideas and subjects. Conceptually, scientific literacy is a process in which some scientific activities happened in response to everyday issues. Operationally, scientific literacy is an ability to apply scientific knowledge and understanding in certain context, and take an action. According to American Association for the Advancement of Science (AAAS), scientific literacy should be taught the way scientists do, starting from presenting a question or a problem, stating hypothesis, until form or revise a theory (1993). Scientific literacy cannot be taught or explained in a book, it is a collective responsibility and consciousness of society in order to act scientifically that can save our planet for being more threatened. In other words, scientific literacy must be lived-in (Roth & Barton, 2004). Thus, education is the main way to change scientific literacy as community responsibility into collective responsibility. However, it is not a guarantee that educated ones will possess the very good level of scientific literacy. Crowell and Schunn (2015) found that science course taking and applied scientific literacy have a very week relationship. The level of scientific literacy can be seen in the quality of science education rather than the quantity of science course.

To achieve scientific literacy, there are two dimensions in its process: (1) curricular and (2) methodological. Curricular dimensions consist of two components: (1) scientific skills and (2) content. The target of a science curriculum should be knowledge of the concepts and scientific principles, and the development of scientific skills and knowledge taught by the history of science. It implies that teachers need to include socio – scientific issues in their lessons. From curriculum point of view, teachers need to be assisted by the training program which goal is to design programs of scientific literacy depending on socio – cultural characteristics of their students in order to develop significant learning context. Scientific literacy skills can be identified as: (1) skills on use and recognition of investigation methods, lead to

scientific knowledge and (2) skills on organizing, analyzing, interpreting data and scientific information. Meanwhile, to manage contents in classrooms, it means to motivate students to seriously take learning activities for scientific literacy. It can be achieved by scientific information exchange and access new resources and internet. Methodological dimension also consists of two components: (1) methods and (2) means used in the educational process for training and developing skills for scientific literacy (Dragos & Mih, 2015: 167–172). Explicitly, there were some indicators of teaching and learning processes that supports students' SL: 1) to look at all aspects in life, including the phenomena, 2) to look for the controversional issues in science, and 3) to develop questions (Seddon, 2017). The phenomena needed is the effective phenomena that can motivate students to know more in urgent. Moreover, the controversial issues needed is the issues that have many perspectives or claims. The questions that will support students is the questions that the students will try to answer.

Based on Dragos & Mih (2015), to have argumentation and scientific reasoning are very important for developing scientific ability but mostly missed from scientific learning efforts. Learning process supposed to present it at class to prepare students in facing information that constantly changing. They must be able to stand for their argumentations, reasoning, and information they have. The information that they have and believe in, must be located, evaluated, and used effectively in order to support the argumentations and reasoning.

Scientific literacy has several foundations, as documented in Manitoba school science curricula that built based on scientific literacy foundations. Those foundations are (1) nature of science and technology, (2) Science, Technology, Society, and Environment (STSE), (3) scientific and technological skills and attitudes, (4) essential science knowledge, and (5) unifying concepts.

Scientific literacy is related to scientific inquiry. Scientific literacy is the brain that leads to scientific inquiry. In scientific inquiry stages, it contains basic

knowledge that researcher needs to have and apply it in their cases and also how they demonstrate their scientific attitudes to answer their questions. The stages of scientific inquiry are: (1) initiating questions, (2) researching some information so researcher can predict, (3) planning their research, (4) do the research by observing, recording, measuring, experimenting, (5) analyze and interpret their data, (6) conclude and apply what they have. Knowledge is used as their background to do brainstorming on their questions. Applying knowledge is being done at the time they do the research and after they conclude. Scientific attitude expressed on how they act upon their question by doing certain research, researcher needs to be sensitive upon their surroundings. To do scientific inquiry, researcher needs five foundations mentioned above.

To measure scientific literacy across OECD countries in the world, PISA held an assessment in 2015. Its framework was knowledge of science and science-based technology. Knowledge of science means concepts, theories, practices, and procedures done. PISA assessment held for 15-year-old students with knowledge they might have already acquired. It assessed how the knowledge required as citizens of their own countries. Thus, PISA formulated a definition of scientific literacy that they assessed as an ability to engage with science-related issues, and with science ideas, as a reflective citizen (OECD, 2016).

Based on PISA science framework, there are three competencies for scientific literacy. First, explaining scientific phenomena. Second, evaluate and design scientific enquiry. Scientific enquiry required is to generate reliable knowledge towards natural world. Both competencies require procedural knowledge and epistemic knowledge. Procedural knowledge means procedures and standard forms in scientific enquiry knowledge or in other words, content knowledge. Epistemic knowledge means knowledge of the roles and functions of science. Third, interpret data and evidence scientifically.

2.3. Scientific Literacy in Taiwan

Scientific literacy in Taiwan has already been investigated that some factors play important role. Private school and public school, female and male, and parents with specialized jobs and parents with no specialized jobs affect students' scientific literacy ability (Yang *et al.*,2012: 45–52). Public school students' have better scientific literacy than private school students'. On the other hand, female pays more attention on science ethics while male has better cognition level than female. It refers to that female have better attitude or behavior in case of scientific literacy and male has better knowledge base to literate science. Students whose parents have specialized jobs, for example doctor and lecturer, have better scientific literacy as well.

Science and technology becomes the foundation of scientific literacy in Taiwan. How citizen uses its knowledge in science and using technology to solve problem or create a solution using their science and technology (S&T). This is because since 1997, Taiwan has decided to promote sci-tech lessons as they realize that S&T is the basis of national competitiveness. Also in the earlier, at 1957, Taiwan has poor scientific environment and shortage of human resources in science. (Lu &Wann, 2015). Thus, basically S&T is their foundation to all form of classroom activities and scientific literacy is their main goal for all the citizen.

CHAPTER 5

CONCLUSION AND SUGGESTION

5.1. Conclusion

According to the discussion of teaching and learning in Jincheng JHS, there are some key activities to support students' scientific literacy, as follows: (1) giving students a room to investigate and satisfy their curiosity in laboratory activities; (2) the use of pictures, tables, and graphs as learning media, questioning activity, and correlating the topic of the lessons to real situations in teaching activities; (3) provide students with science discourse and connecting representation (pictures, tables, graphs) in assessing activities; (4) students are curious about certain phenomena, doing research, and having exercises of interpreting pictures, tables, and graphs to make them questioning so that teachers can guide them to cope with the answers and curiosity in learning activities.

5.2. Suggestion

Based on discussion and conclusion, suggestions can be given as follows:

(1) It would be better if laboratory activities are conducted more often, as written in the textbook

(2) It would be better to give students some mini projects to help them developing inquiry competencies.

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