The analysis of teachers’ readiness to develop science, technology, engineering and mathematics (STEM) based teaching

S O Rukoyah*, A Widodo and D Rochintaniawati

Biology Education Magister Program, Universitas Pendidikan Indonesia

*Corresponding author’s email: sitiooyrukoyah@upi.edu

Abstract. This study aims to explore the readiness of teachers in implementing STEM learning. This was motivated by the fact that schools need to provide teachers who are able to develop learning based on Science, Technology, Engineering and Mathematics (STEM). The research method used was descriptive qualitative research involving each of the 16 teachers in the Lesson Study (LS) and STEM training program and the instrument used a questionnaire given to each teacher. This study shows that there are similarities and differences between each group with the factors that influence it. In the aspect of relevance, it was found that the two groups belonged to the very prepared category. The self-efficacy aspect of the STEM training program is better than LS, whereas in the aspect of anxiety LS is more prepared than the STEM Training group. This is influenced by the fact that the two groups are actively involved in influencing their views on STEM teaching, the STEM training program gets more collaborative learning training and knows the many obstacles in the process of implementing learning.

1. Introduction

STEM competence is the learning approach which refer to science, technology, engineering, and mathematics. For several decades, STEM has held the attention and been recognized widely open as one of the main roles in contemporary knowledge education reformation movement. STEM learning could provide the opportunity for the students to develop their skills in 20th century era. There were critical thinking for a complex problem solving, communication, and collaboration.

STEM competence has a fair role in this modern era, since the students now days are going to be the future generation that will be facing more complex problems in the future. The aim of STEM learning is preparing the students to be able to compete globally, especially the employees was expected to know more about technology. Therefore, it is really important to introduce STEM learning to the students and to encourage them to catch up the STEM subjects in the classroom.

The reason for comparing LS and STEM is to reveal the competence and readiness of natural science (Physics, Chemistry, Biology) teachers in Bandung in implementing STEM-based learning. Given Bandung as the capital of the province of West Java, surely this area will be a benchmark for the successful implementation of STEM-based learning in West Java.

Plenty schools were focused on STEM learning in recent decades. Major programme that held fit on STEM learning process played a main role in introducing and encourage the students in STEM area [1]. However, descriptive research needed more in the class for the teachers’ exercise. This showed that STEM competence needed to follow by the recent situation [2]. Therefore, it’s really important to do
scope investigate, theory, and practical STEM competence in any level of education and in accordance with instructional programme needs to be re-organized [3].

A promising approach to enhance the students' motivation was the use of integrated STEM curriculum [4]. But, the spreading of integrated STEM competence depends on the teacher professional competence, involving by cognitive aspect, affective, and personality, behaviours including to affective aspect, and refer to psychology to clarified one object in a dimension that profitable or unprofitable [5].

The reason for comparing LS and STEM to discover the readiness and competence of science teachers in Bandung in implementing STEM learning. As we know Bandung is the capital city of West Java province so that it would be a successful benchmark for STEM learning in West Java Province. The specific objectives of this research were to discover the science teacher’s readiness that had been participated in STEM workshop in implementing STEM learning process in Bandung.

2. Methods
The research method used was descriptive research. The location of the research was in state junior high school of Lembang and state senior high school of Bandung involved 16 teachers in the Lesson Study (LS) study program and 16 teachers in the STEM training program science teachers. The research was conducted in SMPN 1 Lembang, the subjects were, the teachers that participated in lesson study, and in SMAN 7 Bandung, the subjects were the teachers that participated in dissemination science teaching learning process based on STEM learning by using the technique of questionnaire.

3. Result and Discussion
Result and analysis of the research could be divided into five indicators, they were, integrated science contents, technology, engineering, and mathematics; problem solving learning process; design learning process, and cooperative learning process. The questionnaire result from the teachers who participated in lesson study and the teachers who participated in dissemination science learning process based on STEM competence can be seen below:

| Teachers’ Readiness Aspect         | STEM       |
|-----------------------------------|------------|
|                                   | Lesson Study (%) | Dissemination (%) |
| Integration of STEM content       | 95         | 96         |
| Problem-solving learning          | 86         | 95         |
| Inquiry-based learning            | 96         | 97         |
| Design-based learning             | 92         | 93         |
| Cooperative learning              | 95         | 96         |
| **The average of total readiness** | **95**     | **95**     |

Table 1 show the average results of teachers’ behaviours to STEM learning process (Perceived relevant) to the teachers who participated in lesson study and the teachers who participated in dissemination science learning process based on STEM competence shown that average lowest value was 92% and the highest value 97% which mean had a very good predicate. The total average value of readiness for both research subjects was 95% which mean they were very ready. If analysed by five main principles of STEM (integration science content, technology, engineering, and problem-solving learning process; inquiry learning process; learning process based on design, and cooperative learning) they all had a very good predicate for both research subjects.

The opportunity of professional development involved in professional developing giving the teachers extra professional experiences and because of that it could impact their perspective and behaviours [2]. Several research has been investigated this relationship and concluding that participation in professional development influenced the teachers behaviour to STEM teaching learning process [1].

The following is the teacher's readiness in implementing STEM learning the second indicator is the teacher's self-efficacy in the STEM teaching and learning process.
Table 2. The data of self-efficacy questionnaire result teachers who participated in lesson study and dissemination science teaching learning process based on STEM competence

| Teachers’ Readiness Aspect | STEM Lesson Study (%) | Dissemination (%) |
|----------------------------|-----------------------|-------------------|
| Integration of STEM content| 84                    | 84                |
| Problem-solving learning    | 83                    | 87                |
| Inquiry- based learning     | 98                    | 93                |
| Design- based learning      | 82                    | 92                |
| Cooperative learning        | 83                    | 94                |
| **The average of total readiness (%)** | **84**                | **90**            |

Table 2 showed that the lowest average value of teacher self-efficacy was 82% in a good predicate, whereas the highest value was 92% in a very good predicate. The average value of teacher readiness who participated in lesson study was 84% in ready category, whereas the average value of teacher readiness who participated dissemination science learning process based on STEM competence was 90% in very ready category. The teachers who participated in lesson study and having a very good predicate which suit on STEM main principle which mean learning process based on inquiry because the evidence showed that the teachers asked a lot of questions linked to STEM teaching learning process. As for, the teachers who participated in dissemination science learning process based on STEM competence, from the five principles of STEM competences that having a very good predicate was inquiry learning process principle, design learning process, and cooperative learning. It happened because the teachers who participated in dissemination science learning process involved in many activities that support STEM teaching learning process, started in planning the projects, designing, until making the project that showing a good collaboration between the teachers.

Differentiating types of experiences could be influenced the individual self-efficacy, main indicator of individual behaviour in teaching learning process activity were: a) mastery experience (doing activity) b) representative experience (observing individual do the activity), c) social persuasions (encourage individual to do the activity), and d) emotional desire (feeling unhappy or happy in doing the activity) [6].

The following is the teacher’s readiness in implementing STEM learning the second indicator is the teacher's anxiety in implementing STEM competence.

Table 3. The data of anxiety questionnaire result of the teachers who participated in lesson study and dissemination science learning process based on STEM competence.

| Teachers’ Readiness Aspect | STEM Lesson Study (%) | Dissemination (%) |
|----------------------------|-----------------------|-------------------|
| Integration of STEM content| 68                    | 53                |
| Problem-solving learning    | 63                    | 51                |
| Inquiry- based learning     | 58                    | 46                |
| Design- based learning      | 57                    | 44                |
| Cooperative learning        | 56                    | 46                |
| **The average of total readiness (%)** | **61**                | **48**            |

Table 3 explain about the data shown that the average value of teacher anxiety showed the lowest average value was 44% in less category, and the highest average value was 68% in enough category. Whereas, the average value of teacher readiness who participated in lesson study was 61% in enough category, and the average value of teacher readiness who participated in dissemination science learning process based on STEM competence was 48% in less ready category.

This happened because the teacher who participated in dissemination science learning directly involved in preparing STEM competence and been felt the obstacles that would face. In accordance to cognitive social theory, and behaviours linked in two ways [6]. In means, participation in professional
development could make the teacher having a positive behaviour in implementing teaching learning process of STEM competence by do more participation in professional development. It is different with teachers who do lesson study, they show a less enthusiastic attitude towards STEM learning because they don’t do practical work for learning.

4. Conclusion
Readiness of teachers who take lesson study and STEM training program to develop STEM-based learning teachers’ behaviours towards the STEM learning process (perceived to be relevant, self-efficacy, and anxiety) with the teacher participating in the lesson study and the teacher participating in the dissemination of the science learning process based on STEM competencies showing good attitude. It happened because the teachers who participated in the dissemination of science learning process involved in many activities that support STEM teaching learning process, started in planning the projects, designing, until making the project that shows a good collaboration between the teachers.

5. References
[1] Aldemir J Kermani H 2017 Integrated STEM curriculum Improving educational outcomes for head start children Early Child Development and Care 187 11 1694-706
[2] Brown JS Collins A Duguid P 1989 Situated cognition and the culture of learning Educational researcher 18 1 32-42
[3] Ministry of Education and Employment 2012 A National Curriculum Framework for All
[4] Wyer RS Albarracín D 2005 Belief formation organization and change Cognitive and motivational influences The handbook of attitudes 273-322
[5] Czerniak CM Weber Jr WB Sandmann A Ahern J A 1999 literature review of science and mathematics integration. School Science and Mathematics. 99 8 421-30
[6] Teasdale J D 1978 Self-efficacy Toward a unifying theory of behavioural change? Adv. Behav. Res. Ther. 1 4 211–215

Acknowledgments
We thank for lectures and teachers, involved in this study, for their active participation