Reflective thinking on thermodynamic learning based collaborative problem solving

A R Sinensis\textsuperscript{1,2*}, H Firman\textsuperscript{1}, I Hamidah\textsuperscript{1}, and Muslim\textsuperscript{1}

\textsuperscript{1}Program Studi Pendidikan IPA, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia.
\textsuperscript{2}Program Studi Pendidikan Fisika, STKIP Nurul Huda Oku Timur, Jl. Kotabaru Sukaraja, Buay Madang, OKU Timur, Sumatera Selatan 32161, Indonesia.

*Corresponding author’s email: arinirosa@student.upi.edu

Abstract. This study aims to improve the ability of reflective thinking through collaborative problem solving based on thermodynamic learning. The method used is descriptive quantitative analysis, a sample of 16 prospective physics teacher students who are following thermodynamic learning. The instrument used in this study uses a modified Kember reflective level scale. This research was conducted for 3 meetings but began by holding a pre-test to see the improvement of students' reflective thinking skills from the beginning to the 3rd meeting, the learning model used was collaborative problem solving. The results showed that reflective thinking ability increased at Reflection and Critical Reflection levels while in habitual action and understanding did not increase. This shows that through the application of collaborative problem solving models in thermodynamic learning can improve the ability of reflective thinking students of physics teacher candidates on high-level thinking.

1. Introduction
Capacity building in the 21st Century is a very fast and sustainable development throughout the world. Development leads to production and leads to further development. Therefore it is very important to improve the thinking capacity of the community to face challenges in this century. Two very important thoughts are the ability to think critically and think reflective [1]. In the world of education in recent years, reflective thinking has been able to improve some of the skills and basic needs of students and teachers and to contribute to the educational environment [2].

At present there are many articles about learning, which only promote the reactions and practices of learning developed, but few explain or promote how learning goals are achieved, assessing whether students are involved in reflective thinking and if so to what extent [3]. Though this is very important as an evaluation in the development of a learning and curriculum that is used. The ability to think reflective for teacher and student teacher candidates is very important to be improved as a reflection of the extent, what is the next action, about how to think again to solve problems. On the world of Education is very important to create a good learning environment, meaningful and make innovations from teaching and learning activities [4]. This is an effort to improve the ability of reflective thinking of teachers or prospective teachers.

In a problem-based learning environment, students are very closely connected with unstructured problems and are reflective of their own understanding [5]. That is to find out how far they can understand the learning that is being followed. In this study aims to improve the ability of reflective thinking in thermodynamics courses using a collaborative problem solving model. In this learning
students are required to understand concepts, apply concepts, and train in solving problems from finding problems, analyzing, providing alternative solutions and giving conclusions through collaborative activities. Through collaborative problem solving students discuss problems, explain and justify their opinions, debate, describe, and reflect on their collective knowledge [6]. Team work is also one way to improve reflective skills for teachers [7]. Reflective thinking is in accordance with the input-process and output of the problem-solving process while problem solving is seen as one of the important skills students must possess [8].

2. Methods
The method in this study uses descriptive quantitative analysis method. Data collection techniques use a reflective thinking scale that is developed and tested by [3] is an instrument to assess the extent to which students are involved in reflective thinking during the lecture program. The scale of Kember reflective thinking has been modified and tested for validation. The reflective thinking scale consists of 16 items, then developed into 24 items consisting of 6 statements, each aspect namely 1) Habitual action, 2) Understanding, 3) Reflection and 4) Critical Reflection. The sample used in this study was 16 prospective teacher students Physics education who took part in thermodynamics-based collaborative problem solving lectures. Reflective thinking scale is given to students at pre-test and at the end of lecture meetings 1, 2 and 3. Data analysis techniques using quantitative descriptive analysis aims to determine whether there is an increase in the level of reflective thinking at each meeting in thermodynamic learning based on collaborative problem solving. The research stages are shown in the Figure 1 below.

3. Result and Discussion
The results of the study show that the level of reflective thinking ability of prospective physics teacher students before and after taking thermodynamic-based learning on collaborative problem solving is shown in Figure 2.
Based on the results of data analysis in Figure 2, the level of reflective thinking on the Habitual Action (HA) aspect during the pre-test, meetings 1, 2 and 3 did not experience a significant increase. It is explained that the average student is still in the low level of thinking still dominates such as memorization and repetition of learning, activities that are often done or automatic [9]. Low habitual action at meeting 3 is 60%, which causes low HA is the finding of a low percentage of the statement on item 1 "I am used to working on problems about work in thermodynamics and can do well without having to think about what applications in physics or anything else" a percentage of 38.75% of students answered in agreement, and 61.25% of students said they did not agree. This explains that students are not used to working on thermodynamic problems and are not used to working well. Likewise the aspects of Understanding (Und) indicate that there is no significant increase. In this case, it shows that students at some meetings still have low-level thinking where they can achieve understanding of concepts without reflecting the significance of personal or practical conditions [9].

Different from Habitual Action and Understanding Reflection (RF) aspects show an increase in each meeting. This shows that high-level thinking of students has increased at each meeting. This means that students can re-examine, explore and clarify a problem through experience or activity carried out to produce a different conceptual perspective in problem solving [9-10]. Likewise the Critical Reflection (CR) aspect shows that there is an increase in each meeting. This shows that the higher level of thinking ability of students increases, namely students are able to analyse and criticize information at a high level, namely reflection, and critical reflection [11].

Increased reflection thinking at reflection and critical reflection levels shows that through the learning model collaborative problem solving can improve reflection thinking skills, namely high-level thinking. As in research [12] that the analysis of improvement in reflective thinking can be influenced by the learning model used and the active involvement of students in learning. Through reflective thinking students can identify positive and negative aspects of group work experience, reflect on the whole process, and improve collaborative skills for the future [13]. Improved reflective thinking of students is also influenced by lecturers' evaluation of learning activities to improve deficiencies in the application of learning. Many improvements were made, namely at the stage of exploring the problem and reflecting this to improve the quality of learning so that the next meeting would be better. Teachers and prospective teachers are also important in participating in activities to develop reflection thoughts [2].
4. Conclusion

Based on the results of data analysis it can be concluded that through collaborative problem solving activities in thermodynamic learning can improve reflection thinking skills, especially in the aspects of reflection and critical reflection. In the aspect of habitual action and understanding there was no significant increase, this shows that students are still thinking in a low level, namely acting according to their habits and understanding. Through collaborative problem solving activities students can observe, identify, assess and make decisions and reflect so that students can interpret learning that they have not or have done. Improved reflection thinking is also influenced by the evaluation of lecturers on the learning carried out at each meeting aimed at improvement. This evaluation activity is also one of the reflection activities. Improved reflection thinking can also be enhanced by other learning models, namely learning that activates students in thinking, psychomotor and affective activities in solving problems.

5. References

[1] Demir S 2015 Evaluation of Critical Thinking and Reflective Thinking Skills among Science Teacher Candidates *Journal of Education and Practice* 6 18 p. 17–21.
[2] Sağır U et al 2016 Investigation of the relationship between pre-service science teachers’ perceived self-efficacy in science teaching and disposition toward reflective thinking *European Journal of Science and Mathematics Education* 4 3 p 331–345.
[3] Kember D et al., 2000 Development of a questionnaire to measure the level of reflective thinking *Assessment & evaluation in higher education* 25 4 p. 381–395.
[4] Mirzaei F, Phang F A and Kashefi H, 2014 Assessing and Improving Reflective Thinking of Experienced and Inexperienced Teachers *Procedia-Social and Behavioral Sciences* 141 p. 633–639.
[5] Yuen Lie Lim L A 2011 A comparison of students’ reflective thinking across different years in a problem-based learning environment *Instructional Science* 39 2 p. 171–188.
[6] Antonenko P, Jahanzad F and Greenwood C, 2015 Research and Teaching: Fostering Collaborative Problem Solving and 21st Century Skills Using the DEEPER Scaffolding Framework *Journal of College Science Teaching* 043 09 pp 76-79
[7] Mirzaei F, Phang F A and Kashefi H, 2014 Measuring Teachers Reflective Thinking Skills *Procedia-Social and Behavioral Sciences* 141 p. 640–647.
[8] Sen H S, 2013 Reflective thinking skills of primary school students based on problem solving ability *International Journal of Academic Research* 5 5 p 41–48.
[9] Kember D, McKay J, Sinclair K and Kam Yuet Wong F, 2008 A four-category scheme for coding and assessing the level of reflection in written work *Assessment & evaluation in higher education* 33 4 p. 369–379.
[10] Boyd E M and Fales A W, 1983 Reflective learning: Key to Learning from Experience *Journal of humanistic psychology* 23 2 p 99–117.
[11] Ghanizadeh A and Jahedizadeh S, 2017 Validating the Persian Version of Reflective Thinking Questionnaire and Probing Iranian University Students’ Reflective Thinking and Academic Achievement *International Journal of Instruction* 10 3 p 209–226.
[12] Rahimi N H Z, Mat Rashid A and Hamzah R, 2015 Hubungan Antara Penglibatan Dalam Teknikal Dan Vokasional *Journal of Human Capital Development (JHCD)* 8 1 p. 105–120.
[13] Satjatam P, Sarintip R and Teerachai N, 2016 Developing reflective thinking instructional model for enhancing students desirable learning outcomes *Educational Research and Reviews* 11 6 p. 238–251.

Acknowledgments

Thanks to the LPDP (Lembaga Pengelola Dana Pendidikan) or Indonesia Endowment Fund for Education from the Indonesian Ministry of Finance who has provided financial support to support the author in this research and writing.