Classification of Student’s Mathematical Reflective Thinking in Calculus Class

R L Ariany1,2*, T T Widiastuti2, A L R Jauhari1,3 and F Fardillah1,4

1 Universitas Pendidikan Indonesia, 229 Setiabudhi Street, Bandung, Indonesia
2 UIN Sunan Gunung Djati Bandung, 105 A.H Nasution Street, Bandung, Indonesia
3 Universitas Pasundan, 68 Lengkong Besar Street, Bandung, Indonesia
4 Universitas Muhammadiyah Tangerang, Tangerang, Indonesia

*rivalestaariany@upi.edu

Abstract. Reflective thinking is an important ability that supports professional skills, the teacher is a professional position so that reflective thinking is important to be owned by prospective teacher. This study aims to identify the reflective thinking skills of prospective mathematics teachers. The research conducted is a descriptive study with a survey model. Data collection techniques used by the mathematical reflective thinking test. The study involved 30 prospective mathematics teachers. The results showed that more than half of students did not reach the reflection stage, only a small proportion of students had done critical thinking. The development of reflective learning is needed, so that reflective thinking can be developed effectively in learning.

1. Introduction
Reflective thinking is a high-level thinking ability needed by someone to build professional skills [1], one of the professional fields is the teacher, so prospective teachers also need to have adequate reflective thinking skills. Teachers and teacher candidates are important factors in education, therefore it is very important to analyze their reflective thinking abilities and innovative skills [2]. Reflective thinking includes a series of logical thinking, analysis, non-algorithmic problem solving. Reflective abilities include high-level mathematical abilities that involve extracting meaning, and involving multiple criteria. Based on this reflective thinking should be owned by prospective mathematics teachers, this is also supported by previous research that examines a lot of the prospective teacher's reflective thinking skills [3], [2]. Reflective thinking is active and conscious thinking in the process of making meaning [4], [5]. According to Korthagen, reflective thinking is also a "mental process of structuring or restructuring experiences, problems, or existing knowledge or insights" [5]. Reflective thinking ability is the ability to think with attention to assumptions (hypotheses of known elements) and their implications based on reason or evidence to support conclusions [6].

Mezirow introduces four main constructs of reflective thinking, namely; habitual actions, understanding, reflection, and critical reflection [7]. Habitual action is defined as what has been learned before and through use that is often done automatically or with little awareness of thinking. The second component, that is, understanding is learning and reading without being related to other situations or applying prior knowledge without wise evaluation [7]. The third is reflective, someone at this stage is aware of what they know and what they need to know [8]. Reflection involves active, persistent and careful consideration of any assumptions or beliefs based on one's circumstances. The final category is critical reflection that involves awareness of the reasons behind our perceptions, emotions, and actions.
This requires recognizing that our activities are governed by values and beliefs and requires a critical assessment of the assumptions of previous learning [7]. Critical reflection is considered as a higher level of reflective thinking that causes a person to become more aware of how to look at a problem, explore a problem, and act to solve a problem. A person who reflects all his practices not only looks back at past actions and events, but looks consciously at emotions, experiences, actions, responses, and uses that information to add to the existing knowledge base and reach a higher level of understanding [3]. Critical thinking is the highest level of reflective thought process that can be indicated by knowing deeply the reason for someone to feel things. At this stage students are able to decide and solve a solution.

2. Method
The survey model as a form of descriptive research is used in this study to investigate students' thinking abilities. Specifically, the purpose of this study is to find out: 1) The tendency of students' reflective thinking levels, 2) How students' reflective thinking skills are in solving many problems of variable calculus.

This research involved the second year mathematics education department student at an Islamic university in Bandung. Students who participated were students of the 2019-2020 school year consisting of 30 students drawn from 3 existing classes. Data were collected using students' mathematical reflective thinking tests.

Data obtained from students' mathematical reflective thinking tests were analyzed using content analysis. Data that is similar to each other is collected within the framework of certain concepts and themes; the data is compiled, and interpreted. In line with this technique, data is classified and evaluated. The data is then analyzed, calculated frequency (f) and percentage (%) [9].

3. Result and Discussion
Based on the results of the student's mathematical reflective thinking ability test in many variable calculus courses, students can be classified into 4 groups, namely habitual action, understanding, reflection and critical reflection. The results showed that 83% of students did not reflect on the problem solving that had been done, 63% of students were at the level of habitual action, 20% of students at the level of understanding, 10% of students were categorized at the reflection stage, and students belonging to the critical reflection 7%.

A clearer picture can be seen in the results of students' reflective thinking tests, where students are given a limit to prove. More than 4/5 students do not do enough reflection in solving problems, they generally answer questions without pondering them first, problems are answered in a short time without further analyzing sufficient requirements and necessary conditions of the problem given. The response given is like a reflex motion without much consideration "just finish", generally from them having difficulty connecting the relationship of the new problem with the concept they have learned before. Students do not consider the conditions that a limit exists. Students prove a limit that does not exist, using the definition. This means that students reflexively prove that a limit exists, without first ascertaining whether or not there is a limit with a trajectory test. Overview of student work can be seen in figure 1.

Students who are in habitual action group, without hesitation make proof, which actually cannot or does not need to be proven. Students without thinking long prove that a clear limit does not exist, they prove using the definition of a limit. While students who have reached the stage of understanding can already use previous knowledge by conducting a trajectory test to see whether the limit exists, but only to the extent of it. They continue to prove the limit, so that the knowledge they have is used, but not used further to make a wise evaluation to answer the problem given.

Students at the reflective stage are already able to evaluate, explore, examine and clarify existing problems. In this case, students already know that to prove a limit, it must first be checked whether the limit exists. After carrying out the test limit or not, then evaluated whether the results of the examination can be used to answer the problem or not. Students who are included in the reflection category have been able to summarize the results of the evaluation conducted. Most of them realize that the limit does not exist, but still do the steps to prove the limit according to the definition and some others only until checking the limit exists, have not reached the conclusion whether the limit can be proven, or even does
not need to be proven by definition. Thus it appears that the evaluation has not reached the belief that the limit does not need to be proven because the limit itself does not exist. Ideally in this problem students are able to explore the problem, examine, clarify and analyze with full awareness to the conclusion that limits do not exist, do not need to be proven and students are well aware of the underlying reasons in depth. When they have reached this stage, students are included in the category of critical thinking.

Figure 1. This picture shows that students do not reflect, the limit does not exist, it is still proven by using a definition which is pointless.

4. Conclusion

Based on the results obtained, reflective thinking still needs to be developed in the learning process. Therefore it is necessary to design learning that can facilitate students to be able to develop their reflective thinking, according to their initial abilities, but get equally satisfying results at the end of the program. Schon triggered about reflective practitioners than stated that reflective thinking can develop by involving students in reflective practice [10]. One example of reflective practice in class is to ask questions that require evidence and explanation. Reflective thinking is a problem-solving process that provides an interesting gap for further research, namely seeing how problem-solving abilities affect reflective thinking or vice versa.

References

[1] F. Dervent, “The effect of reflective thinking on the teaching practices of preservice physical education teachers,” vol. 25, no. 3, pp. 260–275, 2015.
[2] C. Koçak and aysem S. Onen, “Analysis On Reflective Thinking Tendencies Of Student Teachers
According To Their Individual Innovativeness And Sociotropic- Autonomic Personality Characteristics,” in CY-ICER, 2014, vol. 143, pp. 788–793.

[3] P. Mathew, P. Mathew, and J. Peechattu, “Reflective practices: a means to teacher development,” Asia Pacific J. Contemp. Educ. Technol., vol. 3, no. 1, pp. 1–6, 2017.

[4] E. E. Balta, “Reflective Thinking Tendencies and Epistemological Beliefs in Terms of Learning Styles,” vol. 7, no. 6, pp. 106–117, 2018.

[5] E. Adadan, “Examining Preservice Teachers ’ Reflective Thinking Skills in the context of Web-Based Portfolios : The Role of Metacognitive Awareness,” Aust. J. Teach. Educ., vol. 43, no. 11, pp. 26–50, 2018.

[6] A. Fuady, “Berfikir reflektif dalam pembelajaran matematika,” J. Ilm. Pendidik. Mat., vol. 1, no. 2, pp. 104–112, 2017.

[7] A. Ghanizadeh and S. Jahedizadeh, “Validating the Persian Version of Reflective Thinking Questionnaire and Probing Iranian University Students â€™ Reflective Thinking and Academic Achievement,” Int. J. Instr., vol. 10, no. 3, pp. 209–226, 2017.

[8] A. Asakereh and N. Yousofi, “Reflective Thinking , Self- efficacy , Self-esteem and Academic Achievement of Iranian EFL students,” Int. J. Educ. Psychol., vol. 7, no. 1, pp. 68–89, 2018.

[9] U. Toman, S. O. Cimer, and A. Cimer, “ANALYSIS OF PRE-SERVICE SCIENCE TEACHERS ’ VIEWS ABOUT THE METHODS WHICH,” Int. J. New Trends Educ. Their Implic., vol. 5, no. 4, pp. 162–172, 2014.

[10] F. Khalid, M. Ahmad, A. A. Karim, Y. Daud, and R. Din, “Reflective Thinking : An Analysis of Students ’ Reflections in Their Learning about Computers in Education,” Creat. Educ., vol. 6, pp. 2160–2168, 2015.