Physics pre-service argumentation to increase reflective thinking capabilities

R Rosmiati1,4*, Liliasari S1, B Tjasyono2 and T R Ramalis3

1Program Studi Pendidikan IPA, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setia Budhi No. 229, Bandung 40154, Indonesia
2Departemen Meteorologi, Institut Teknologi Bandung, Jl.Ganesha No. 10, Bandung 0132, Indonesia
3Departemen Pendidikan Fisika, Universitas Pendidikan Indonesia, Jl. Dr. Setia Budhi No. 229, Bandung 40154, Indonesia
4Departemen Pendidikan Fisika, STKIP BIMA, Jl. Piere Tendean Kelurahan Mande, Kota Bima 84111, Indonesia

*Corresponding author’s email: rosmiati.stkipbima@gmail.com

Abstract. The developing reflective thinking skills (RF) for pre-service teachers is very important. It made pre-service teacherstry to integrate the ability to think reflective in the teaching process. The study aims to explore the ability of argumentation that has been constructed into the reflective thinking process. It purpose to enhance the reflective thinking capabilities of physics pre-service teachers’ climate prediction material. The respondent of this research were three respondents. The data obtained in the form of arguments by determining claims, warrant and backing qualitatively. Data were analyzed by using descriptive explorative technique. Based on the results of data analysis, the pre-service teachers’ reflective thinking ability was seen from the results of the argumentation. We described three different level for respondent reflective thinking capability in which the first respondent in resolution level, the second respondent in exploration level, and the third respondent in triggering event level. This means that the reconstruction of the reflective thinking process by including the arguments was very effective to explore the reflective thinking capabilities of pre-service teachers.

1. Introduction

Reflective thinking skills (RF) are high-level thinking skills that very important to train pre-service teachers [1,2]. If they are continuously applied this reflective thinking skills, it will make them become expert in solving material problems from various perspectives. It make pre-service teacher to think a different strategies in formulating solutions to get the right and elegant solution [3]. Teachers strive to integrate the ability of reflective thinking in the teaching process. There are several studies have been conducted to measure the level of reflective thinking of pre-service teacher [4,5,6]. The most important factor in reflective thinking research is remembering structured information, reading by understanding and interpreting text, understanding problems and making decisions [7,8]. Some ways to improve the capabilities of reflective thinking are by writing essays, diaries, notebooks, portfolios and journals, that have been used to improve the reflective thinking process, then expanded using more technology-oriented online methods such as e-portfolios, e-journals, and blogs [9]. These methods aim to improve sustainable professional development in education. From these methods the
most important process using argumentation. Argumentation is the link between knowledge originating from the environment and concepts in learning [10,11] and as a controller of student understanding in relating facts to concepts in learning. in the revised taxonomy of Bloom the argument is Evaluating (C5) which means at the higher order level thinking skills [12].

Analyzing reflective thinking is based on Reflection on Action Approach [13] which describes cognitive development as a social process [14]. This process includes intellectual activities that combine feelings and reciprocal communication and the relationship between facts and concepts in learning. From the statement it can be seen the relationship between reflective thinking with argumentation, that arguments can be in the form of essays in writing or presentation.

Increasing the ability to think reflectively through the process of argumentation is a reconstruction of the reflective thinking process. It is expected that pre-service teachers can solve problems in various fields through an argumentation process to improve reflective thinking capability. Some researchers think reflective on pre-service teachers students with different processes. This study will describe the argumentation process to improve the capability of physics pre-service teachers’ reflective thinking in climate prediction matter. The important question in this study is how the process of arguing for physics pre-service teachers in climate prediction matrices. This analysis includes: (i) Reconstruction of the reflective thinking process (ii) the ability of students to determine claims, warrant and backing.

To collect data, it is necessary to do a climate prediction essay test to predict the phenomenon of Indian Ocean Dipole (IOD) for the next 6 months.

### 2. Methods

The study was conducted on January 3, 2019 at the LAPAN Bandung Sciences and Atmospheric Center, with the number of respondents were 3 pre-service physics teacher from one of the universities in Center of Java. They were carrying out the final task of researching climate prediction namely the phenomenon of Indian ocean dipole (IOD) for the next 6 months. The instrument used is the worksheet IOD predictions. Students predict the IOD phenomenon to produce data and then argue to determine claims, warrant and backing. **Claim:** Negative anomalies from the IOD index cause high rainfall in the Nusa Tenggara and Bali regions, causing floods, while positive anomalies cause reduced rainfall which causes drought and lack of water. IOD predictions for the next 6 months in the August 2018 - April 2019 period show normal anomalies reaching 0.90 with original IOD data correlation with predictive data of 0.77. **Warrant:** The NusaTenggara and Bali regions have clear differences between the rainy season and the dry season, the Sea Surface Temperature (SPL) in the Indian Ocean is very influential on the pattern of rain in the study area. As seen in the table of extreme weather applications carried out by analyzing short-term periods of 2015-2018, rainfall data and IOD model data have different phases. When the IOD is positively phased, rainfall in the study area decreases, hot ponds on the near coast of Africa occur when the west coast of Sumatra is high pressure, while the east coast of the African continent is low pressure so that air flows from the western part of Sumatra to the eastern part of Africa resulting in the formation of convective clouds in the African region and producing rainfall above normal.

On the contrary, in the West Sumatra, there was a high level after the mass of water vapor failed as rain. Conversely, when IOD is in the negative phase, rainfall in the study area increases rainfall. But there are several phases when negative IOD, negative rainfall and positive IOD, rainfall is also positive. From the table data the size of forecasting accuracy with a prediction period of 6 months correlation of 0.90 shows that the IOD anomaly will continue to decline. **Backing:** The main characteristic of the territory of Indonesia is a mixture of land and sea surface, covering 70% of the ocean and 30% of land, located between the Pacific Ocean and Indian Ocean and the Asian continent and the Australian continent, thus forming the Indonesian maritime continent (BMI) areas in the equatorial region where tropospheric convection and formation of the most active Columbus clouds are the main sources of the Earth's atmosphere which controls the world's climate.

Claims, warrants and backing in accordance with the above arguments are assessed according to the level of indicators of the reflective thinking process that has been reconstructed, It is (1) trigger
events (Recognizing problems) (2) exploration (brainstorming) (3) integration (synthesizing and creating Solutions) (4) Resolution (Application solutions and Reflections). Data obtained is presented descriptively. The techniques used in data collection are data on the reconstruction of reflective thinking processes and predictive worksheets for students who have studied climate prediction.

3. Result and discussion

Toulmin divided the structure of the argument into two groups, namely the basic group and the follow-up group [15,16]. The researchers combined into 1 main group to measure the quality of argumentation by determining claims, warrant and backing. Three respondents each argued the results of the IOD prediction. from Claim, warrant and backing can measure reflective thinking capabilities as be seen in Table 1.

Table 1. Results of student activity analysis in PBL process

| Respon dent | Argumentation | Reflective thinking indicators |
|-------------|---------------|-------------------------------|
| 1 M         | A negative anomaly of IOD will cause an increasing rainfall phenomenon, especially in the Jogyakarta area which causes floods and landslides. Whereas when IOD positive anomaly will cause a decreasing rainfall phenomenon. IOD prediction for the next 6 months shows a correlation of 0.85. | The territory of Indonesia consists of 30% of the land and 70% of the ocean, located in the Pacific Ocean and the Indian Ocean and the continents of Asia and the continent of Australia so that BMI is formed. The condition of Indonesia affects the type of Indonesian rainfall, which is monsoonal, equatorial and local. Rainfall data is used to see the effect of IOD on rainfall. Rainfall data in Jogyakarta is the type of U-shaped distribution with the lowest seasonal rainfall in the dry month (JJA) and the highest in the wet month (DJF), besides IOD rainfall is also influenced by MJO, Monsoon and ENSO | Resolution (application solutions & reflections / arguments) |
| 2 U         | Based on the IOD phenomenon in 2015/2016 the impact of extreme drought and extreme wetness in several regions. The application of the IOD model with rainfall in Denpasar shows that there is a long dry season in April-October IOD is the interaction between the atmosphere and the ocean in the Indian Ocean. Positive IOD occurs when the coastal region of the African continent is low pressure so that air flows from the western part of Sumatra to parts of Africa and produce | Exploration (brainstorming) |
Based on the overall argumentation results in table 1, the three respondents had different levels of reflective thinking skills. Respondent 1 has a better level of reflective thinking than respondent 2 and respondent 3 is at the Resolution level which is the highest level of reflective thinking process. This is caused by respondents 1 not only being able to provide solutions but also able to apply real solutions and be able to maintain the solution. In addition, if viewed from the process of argumentation (claim, warrant and backing), Respondent 1 is far better solution than the other two respondents. This can be seen in the argumentation process, where in the claim process respondent 1 was able to discuss the causes of positive and negative anomalies and the model correlation results and significant predictive results [17], in the warrant in detail explaining the process of drought and rain due to shifting warm pools in the Indian Ocean [18], on the backing discusses the characteristics of the Indonesian maritime continent from the location of the Earth map [19] and the topography then associated with rainfall in Yogyakarta [20].

Another thing that can be seen from table 1 is that respondent 2 has the ability to think reflective on the level of exploration while respondent 2 is able to provide some information that supports the resolution of a problem but has not been able to produce a solution. Besides that, it can also be seen from the process of argumentation (claim, warrant, and backing) where in the claim process respondent 2 provides information that IOD has an effect on rainfall in Indonesia, without explaining the causes of positive and negative anomalies and their correlation. The warrant process only provides information about long droughts in 2015/2016 due to IOD [21] and does not explain the process of shifting hot pools. In the backing process the respondent 2 provides information about the movement of hot pools, which should be explained in the warrant process.

In contrast to respondents 1 and 2, respondents 3 have the ability to think reflective at the level of the trigger event which is the lowest level. This can be seen by the respond only being able to recognize problems without providing important information to provide a solution. In addition, when viewed from the argumentation process (claim, warrant, and backing) where the claim process only
states that IOD has an effect on rainfall in Indonesia, the warrant only explains the claim, which is the cause of positive and negative anomalies. in the Indian Ocean causing the IOD phenomenon, this statement should be explained in a warrant not a backing.

In general respondents 1 intellectually manage to combine feelings and reciprocal communication and the relationship between facts and concepts in learning climate prediction material [22] and have met these criteria and have high reflective thinking capabilities while respondents 2 have moderate reflective thinking capabilities and respondents 3 have thinking capabilities low reflective. The reflective thinking must meet the criteria of being able to connect new knowledge from previous knowledge [8, 23], think abstractly and conceptually, apply specific strategies in new tasks, and understand their own thinking and learning strategies [24, 25]

4. Conclusions
Based on the results of discussions on issues related to argumentation by determining claim, warrant and backing, it improves the capability of reflective thinking of prospective teachers. Regarding predictions of IOD in the next 6 months, it can be concluded that out of 3 respondents, the first respondent had high reflective capabilities moderate reflective capability. The 3rd respondent has low reflective capability. The reconstruction of the reflective thinking process by including the arguments was very effective to explore the reflective thinking capabilities of pre-service teachers on climate prediction material.

References
[1] Tican, C Taspinar and Mehmet 2015 The effects of reflective thinking-based teaching activities on pre-service teachers’ reflective thinking skills, critical thinking skills, democratic attitudes, and academic achievement The Anthropologist 12 111-120
[2] Kim, Y Silver and R Elaine 2016 Provoking reflective thinking in post observation conversations Journal of Teacher Education 67 3 203-219
[3] Ellianawati, Rusdiana D and Sabandar J 2015 Berpikir Reflektif sebagai Proses Berpikir Kritis dan Kreatif: Suatu Tinjauan pada Konteks Keterampilan Mahasiswa dalam Proses Penyelesaian Masalah Fisika Matematika Seminar Nasional IPA VI Semarang
[4] Guroğlu A 2011 Determining the reflective thinking skills of pre-service teachers in learning and teaching process Energy Education Science and Technology Part B: Social and Educational Studies 3 3 387-402
[5] Mirzaei F, Phang F A and Kashefi H 2014 Assessing and improving reflective thinking of experienced and inexperienced teachers Procedia-Social and Behavioral Sciences 141 633-9
[6] Agustan S, Juniati D and Siswono T Y 2017 Reflective thinking in solving an algebra problem: a case study of field independent-prospective teacher InJournal of Physics: Conference Series 893 1 012002
[7] Choy S C and San Oo P 2012 Reflective thinking and teaching practices: A precursor for incorporating critical thinking into the classroom? International Journal of Instruction 5 1
[8] Mirzaei F, Phang F A and Kashefi H 2014 Assessing and improving reflective thinking of experienced and inexperienced teachers Procedia-Social and Behavioral Sciences 141 633-9
[9] Tsingos-Lucas C, Bosnic-Anticevich S, Schneider C R and Smith L 2016 The effect of reflective activities on reflective thinking ability in an undergraduate pharmacy curriculum American journal of pharmaceutical education 80 4 65
[10] Anisa A, Widodo A, Riandi R and Muslim M 2019 Exploring high school student’s argumentation structure through ecology: a case study InJournal of Physics: Conference Series 1157 2 022091
[11] Pratiwi S N, Cari C, Aminah N S and Affandy H 2019 Problem-Based Learning with Argumentation Skills to Improve Students’ Concept Understanding InJournal of Physics: Conference Series 1155 1 012065
[12] Ramos J L, Dolipas B B and Villamor B B 2013 Higher order thinking skills and academic
performance in physics of college students: A regression analysis *International Journal of Innovative Interdisciplinary Research* 4 1 48-60

[13] Erginel S Ş 2006 Developing reflective teachers: A study on perception and improvement of reflection in pre-service teacher education *Yayımlanmamış Doktora Tezi, Orta Doğu Teknik Üniversitesi: Ankara*

[14] Redmond P 2014 Reflection as an indicator of cognitive presence *E-Learning and Digital Media* 11 1 46-58

[15] Demiral Ü and Çepni S 2018 Examining Argumentation Skills of Preservice Science Teachers in Terms of their Critical Thinking and Content Knowledge Levels: An Example Using GMOs *Journal of Turkish Science Education* 15 3

[16] Suhartoyo E, Mukminatien N and Laksmi E D 2015 The Effect of Toulmin’s Model of Argumentation Within TWPS Strategy on Students’ Critical Thinking on Argumentative Essay *Jurnal Pendidikan Humaniora* 3 2 143-153

[17] Yamanaka M D 2016 Physical climatology of Indonesian maritime continent: An outline to comprehend observational studies *Atmospheric Research* 178 231-259

[18] Roxy M K, Ritika K, Terray P, Murtugudde R, Ashok K & Goswami B N 2015 Drying of Indian subcontinent by rapid Indian Ocean warming and a weakening land-sea thermal gradient *Nature communications* 6 7423

[19] Yamanaka, M D, Ogino S Y, Wu P M, Jun-Ichi H, Mori S, Matsumoto J and Syamsudin F 2018 Maritime continent coastlines controlling Earth’s climate *Progress in Earth and Planetary Science* 5 1 21

[20] Alfahmi F, Boer R, Hidayat R and Sopaheluwakan A 2019 The Impact of Concave Coastline on Rainfall Offshore Distribution over Indonesian Maritime Continent *The Scientific World Journal*

[21] Avia L Q and Sofiati I 2018 Analysis of El Niño and IOD Phenomenon 2015/2016 and Their Impact on Rainfall Variability in Indonesia In *IOP Conference Series: Earth and Environmental Science* 166 1 012034

[22] Rosmiati R and Satriawan M The ocean climate phenomenon: the challenges of earth physics lectures in Indonesia *In Journal of Physics: Conference Series IOP Publishing* 1157 3 p.032038

[23] Kurniawati Y, Permanasari A, Muzakir A and Rohman I 2015 Potential of Reflective Thinking Skills as a Bridge for Students’ Prior-Knowledge and Chemistry Experiments Skills *International Journal of Science and Research (IJSR)* 4 9 216–221

[24] Satriawan M, Liliasari S and Setiawan W 2019 Wave energy concept mastery relate on creative thinking skills of the pre-service physics teachers in environmental physics lectures *In Journal of Physics: Conference Series IOP Publishing* 1157 3 p.032044

**Acknowledgments**

On this occasion the authors would like to express the appreciation and gratitude to BUDI-DN and LPDP as sponsors and all to the participant that has given big impacts to the success and data completion of this research.