



STUDENTS CRITICAL THINKING DEVELOPMENT IN THE NATIONAL SCIENCES AND MATHEMATICS COMPETITION IN INDONESIA: A DESCRIPTIVE STUDY

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ABSTRACT

This study aimed to describe the development of students' critical thinking through their participation in the National Sciences and Mathematic Competition in Indonesia, known as Olimpiade Nasional Matematika dan IPA (ONMIPA). Furthermore, this study investigated the response of the participants towards the administration of ONMIPA in various aspects and also examined support given by the institution to their students related to ONMIPA administration. A qualitative approach implemented to answer the research questions. The instruments used to collect the data were observations list, questionnaire, and interview. The respondents of this study were 54 ONMIPA participants and ten ONMIPA 2019. The study revealed that The National Mathematics and Natural Sciences Olympiad or ONMIPA had excellent potential to develop students' critical thinking skills. The data showed that participants' responses to the administration of ONMIPA were very positive. Besides, the result revealed that Higher education institutions provided support to participants and the administration of ONMIPA. The support was generally excellent and provided in various forms.

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Keywords: critical thinking; ONMIPA; motivation

INTRODUCTION

Indonesia gold, which is the momentum when Indonesia reaches the age of a century. It is a milestone marker for the Indonesian stage to be more advanced. Indonesia expected to draw closer to the title as a nation that could reach its national ideals of independence, unity, sovereignty, justice, and prosperity. Indonesia also expected to be closer to the achievement of our national goals as a nation that is protecting the whole nation, advancing public welfare, educating the nation's life, and participating in carrying out world order.

Indonesia, with its various potentials, seems rationally easy to achieve that goal. Nevertheless, in reality, Indonesia still cannot realize national goals because they still have several challenges. The challenges include the population from an educational side that has not developed optimally. Bappenas (2019) reports that the average education workforce level in Indonesia is under Junior high school, still 57,46%, and those graduates from higher education only 11,8 % from all Indonesian population. Whereas the Indonesian population tertiary education gross enrollment rate only 34,58 % in 2018 (Kemenristekdikti, 2019). The number is still low if we compare it to other countries like Singapore, Korea,

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or Japan. All of these problems make Indonesia get a low rank in the world innovation index, 85th of 127 countries (WIPO Statistic Database, 2017).

Furthermore, based on several survey findings, it shows that the quality of education in Indonesia is still relatively low (Firman H & Tola B, 2008). The low quality of Indonesian human resources results from low education quality. A study conducted by TIMSS shows that Indonesian students have not yet performed satisfactorily (Tjalla, 2019; Rahmawati, 2016). Even the latest results from the ranking of tertiary institutions show that none of the tertiary institutions in Indonesia get ranked in the top 100 in Asia (Webometrics, 2019). And only three universities in Indonesia in the world rank 500 of QS higher education rank (QS World University Ranking, 2020)

Indonesia's higher education expected to respond to many challenges in the work field and to produce graduates who are competitive in the working world. However, Indonesia still has a 60,43% low competency workforce (Bappenas, 2019). The average national unemployment rate about 5,34%, and the unemployment rate for universities graduated about 5,91 % (BPS, 2018). Although currently, many large companies underlie that the acceptance of new employees not merely based on diplomas and transcripts owned by someone. Instead, it based on the competency and soft skills of prospective employees. Mykhailshyn et al. (2018) propose that the modern labor market requires graduates' ability to operate such technologies and knowledge that meet the needs of the information society, prepare young people for new roles in this society.

The development of world technology is now entering the Industrial Revolution 4.0, namely the stage where artificial intelligence, coding, internet of things, big data, new materials, 3D printing, genetic engineering and others coloring our life. The mastery and application of ICT is the key to business and today's work world. Besides the positive aspects of technology, we must also anticipate the negative effect of ICT development in social media. They are hoax spreading, hate speech, news with harmful content, and the likes. Those examples become a threat to the unity of Indonesia as a plural country.

In the 21st century, critical thinking has a significant position in human life because of the abundance of various information from certain sources. Hence, we need the ability to think critically to select and process information. By having the ability to choose the information critically, we

can select the information and will not believe in wrong mislead information. As proposed by Ennis and Norris (1990) that critical thinking is reasonable and reflective thinking that focused upon deciding what to believe and what to do.

Social media strongly influence education that forms the future of one nation. Marshall & Tucker in Facione (2015) argue that the future now belongs to societies that organize themselves for learning. Nations that want high incomes and full employment must develop policies that emphasize the acquisition of knowledge and skills by everyone. To accommodate the rapid development of technology and high expectations of the government and society to universities, the government should continuously encourage universities to explore their potential. Those activities manifested into the priority of three missions of Indonesia higher education (*Tri Dharma Perguruan tinggi*).

The surveys results about the abilities needed to enter the work world and business today include the following various soft skills: people skills, problem-solving skills, leadership, and communication skills. Meanwhile, the surveys also show that the need in the work field is not yet fully optimally equipped in our tertiary education institutions. The work field needs people with several skills such as critical thinking, attention to detail, communication skills, writing skills, and ownership. By having many skills, students have secure connections between their education and their actual lives. Albrecht et al. (2018) state that term education relevance means is to help students make connections between what they do in school and their lives.

Many experts claim that the world of education must develop 6C'S, namely critical thinking, creative thinking, communication, collaboration, character, and citizenship (Wahidin, 2019). In the same line, Gojkov et al. (2015) state that Critical thinking essentially means to leap out of natural currents of thinking and to learn how to examine further or re-examine something which has already become generally accepted knowledge. Critical thinking is about to have the cognitive skills of interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2015). Pradana et al. (2019) research result shows that Indonesia students' critical thinking skills are still lacking.

Roessingh & Chambers (2011) elaborate that there is a distinct shift from a lecture-based approach to an open-ended process-oriented model associated with the critical theory that values inquiry, reflection, negotiation of meaning, case,

and problem-based learning. Raths (1967) and Wahidin (1993) are in the same opinion that education we must implement what so call "teaching for thinking." The teaching for thinking means we must design activities that emphasize thinking in our science learning. We must look for strategy, approach, methods, and technic that emphasize thinking in our learning activities.

Concerning the development of higher education, Indonesian Minister of Education and Culture, Makarim (2019) states that two things became the main priority of education. The two priorities of education, namely the development of learning that emphasizes the development of soft skills and inculcation of competencies rather than mastery of content and concepts in learning.

One of the essential things in pacing the 21st century that should be possessed by the students is critical thinking skills. Many studies indicate that 21st-century skills are essential skills to be given to students in learning (Haviz, 2018). Critical thinking often identified as complex problem solving or also known as the higher-order thinking process, must become one of the essential topics that we developed in a learning activity in our education to build a smart nation.

As an effort to improve the quality of critical thinking skill is developed by mathematics and science learning in various ways. Rustaman (2002) states that quality science learning is learning that reflects the articulation of concept planning, science process skills, and scientific attitude management. In other words, quality science learning means that it not solely intended to cram concepts to students but must also articulate scientific skills training to problem-solving. Moreover, the knowledge and skills of the scientific process are useful for students when dealing with real problems in their lives.

However, in reality, there are still many Mathematics and Natural Sciences taught by only prioritizing mastery of concepts. It is done without caring for the inculcation of thinking skills or mastery of problem-solving skills, logical and rational decision making, and learning that is far from the context of students' daily lives. The result is that many Indonesians, when dealing with everyday problems or natural phenomena, do not use the concepts of Mathematics and Natural Sciences, even as if they have never studied Mathematics and Natural Sciences (Hinduan, 2001). The situation is what we are afraid of, namely learning science that ultimately does not benefit the learners. However, nowadays, science learning in some universities in Indonesia still implement the conventional approach. The typical way

of teaching procedure use in the classroom is the teacher's centered approach. We must change if we want to make smart people for a bright future of Indonesian.

The researcher found that uneasy situation toward education also happens in other countries, in this regard in Bologna. The situation put forwarded by Gojkov et al. (2015) that the Bologna puts studies in a paradoxical situation emphasizing the need for critical thinking, as the most significant teaching aim. On the other hand, it leaves little space to reach it. Quality improvement of learning also must be maximized, both through the classroom activities (curricular and co-curricular) and out of classroom activities (extracurricular).

There are several relevant research with this study, among other research conducted by Guilmette et al. (2019). Guilmette's research showed that university students' past and present extracurricular activities participation (ECAP) was positively associated with goal self-regulation strategies, which, in turn, were related to higher levels of academic success and emotional well being. Universities and colleges should encourage activities participation to support positive adjustment outcomes.

In the Indonesian context, among many efforts in an extracurricular activity is the administration of Olimpiade Nasional Matematika dan IPA (abbreviated as ONMIPA) or National Mathematics and Science Olympiad at the national level among universities in Indonesia. This competition made for several reasons. One of the reasons is to foster student's interest in a STEM field. An issue of fostering interest in students' interests in STEM also proposes in research done by Kelly et al. (2018). Their research finding suggested that competition is an effective way to foster career interest in a specific STEM career.

Connected to the importance of competition in education, Abernathy & Vineyard (2001) also suggested that the Science Olympiad involved students in developing and using science skills and scientific reasoning to build new content knowledge and increase student interest in science. Furthermore, Kuech & Sanford (2014) also administer the research to investigate the correlation between the competition and students' STEM achievement. The research result shows a statistically significant portion of the students competing in the Northern New England Regional Science Bowl Competition. The research report that the event has a positive impact on the participants and fosters learning in science and mathematics.

Toward the situation, Bezanilla et al. (2019) have an opinion that more research should be conducted in line with this study, or complementary areas in order to verify, compare, and contrast the role of the university in the development of critical thinking. Which is a crucial competency for the personal and professional growth of university students. National competition on Science and Mathematics in Indonesia is one way to solve the problem in enhancing students' critical thinking and to develop Indonesian students become more skillful.

Although the scope of this study is comprehensive, researcher limits this study into the following research questions; how to develop critical thinking skills through National mathematics and sciences competition in Indonesia known as National Mathematics and sciences olympiad /ONMIPA)?; what are participants response towards ONMIPA administration?; what are the universities support towards the administration of ONMIPA?

METHODS

This research implemented a descriptive qualitative approach. Fraenkel et al. (2012) state the qualitative approach used to look deeply into various phenomena occurs in the activity. In this case, the research intends to look at several aspects that occur in the administration of ONMIPA.

In line with Gall et al. (2003) statement, qualitative research is research that focuses on facts, problems, cases, and or social phenomena. In order to answer research questions as stated early, this study collected, presented data and observations results based on the phenomena that occurred. Several data collection tools (instruments) used to collect data, namely online questionnaires, observation sheets, interview guides, and supported by documentary study. Respondents of this study were 54 ONMIPA participants and ten judges of ONMIPA 2019, who are chosen by purposive random sampling method.

The questionnaire in the form of google form was given and responded by the research respondents. The data gathered from google form then reduced, tabulated, analyzed, and perform in the form of table and graphic. The data was displayed in the form of table and graphic followed by documenter study and result of an in-depth interview then collected and analyzed the data.

In this study, the researcher prepared the instrument to gather the data, then collected and processed the data. Moreover, the researcher ana-

lysed the data using the qualitative data analysis approach that led to the conclusion of the research. The data management, as mentioned above, followed the stages proposed by Wong (2008); those were data preparation, data collection, data reduction & categorization (coding), displaying, and concluding

RESULTS AND DISCUSSION

Based on the data collected through research data collection instruments in this study, the data will be displayed, analyzed, and discussed as follow.

The order in this section follows the research questions raised in the initial chapter of this article. However, before entering into the discussion that answers the three research questions, the author will put forward some information regarding the administration of ONMIPA 2019.

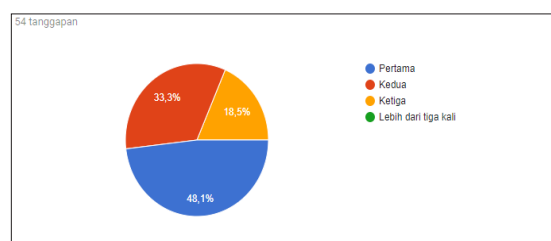


Figure 1. Diagram of Participation in ONMIPA

Figure 1 informs us that of all national ONMIPA participants in 2019, 48.1% were those who first joined ONMIPA. Then 33.3% had participated in ONMIPA twice, and another 18.5% had participated in ONMIPA three times. Information from the diagram above also informed that none of the ONMIPA participants had participated more than three times.

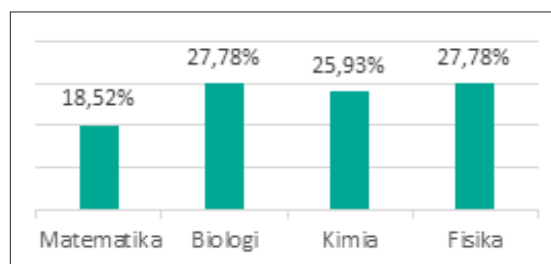


Figure 2. Diagram of Contested Fields

As shown in Figure 2, in ONMIPA 2019, biology and physics dominated the field of competition with the highest number of participants, with the percentage of 27, 78%. After that, the next participants were from the chemical field, with a percentage of 25, 93%. The mathematics is a field of competition with the fewest number of participants that is 18, 52%.

The Development of Critical Thinking in the Administration of ONMIPA

Based on the data, the development of critical thinking in ONMIPA competition, reflected from several things. First, the competition factors in ONMIPA. The competition factor in ONMIPA is an essential thing to stimulate achievement motivation and develop scientific skills and scientific reasoning. Abernathy & Vineyard (2001) suggest that the Science Olympiad involves students in developing and using science skills and scientific reasoning to build new content knowledge and increase student interest in science. Second, ONMIPA competition is raising concept attainment and raising critical thinking skills. Mathematics and Sciences have excellent potential to develop high order thinking skills or critical thinking. The reason is that the concept of Mathematics and Sciences arranged systematically and rationally logic. Besides that, learning Mathematics and Sciences requires laboratory work as well as the potential to instill thinking skills and problem-solving skills. Alatas (2014) research concludes that the correlation between understanding concept and critical thinking skill show a significant correlation with the middle category of correlation. The topics or themes that are subject to ONMIPA are topics that are relevant to real-life today. In the sense that the questions related to current knowledge, nature conservation, environment, misuse of technology, food and beverage technology, health, and the likes (ONMIPA Questions 2017, 2018, 2019). Based on observation, ONMIPA has practical benefits as an effort to draw the quality of education in the country. Also, ONMIPA motivates students to love Mathematics and Sciences, which will significantly benefit the future of Indonesia in terms of mastery of science and technology.

Third, the problem or question of ONMIPA test is emphasized on the critical thinking skill. Moreover, documentary studies are done by analyzing ONMIPA guidelines and ONMIPA problems /test sheet. Whereas, interviews and questionnaires on ONMIPA participants and judges reveal that the inculcation of critical thinking skills was a concern and emphasized in the administration of ONMIPA. Ennis in Pradana (2019) said that critical thinking skills could be measured by multiple-choice with reasoning, performance test, and essay test. Fourth, science concepts in ONMIPA competition are essential concepts. The subject of the tests in ONMIPA is an essential concept that must be mastered by students to underlie the process of thinking or underlying assumptions or concept mastery when

dealing with natural phenomena in relevant student life (see the ONMIPA 2019 guide).

Fifth, the question of ONMIPA test sheet is higher-order thinking (HOT) level question. The analysis of internal questions tested in ONMIPA is a high level in Bloom's cognitive level. These are at the level of application, synthesis, and analysis. Furthermore, the evaluation in ONMIPA is on the highest cognitive of Bloom domain that is creating (ONMIPA questions in 2017, 2018, 2019). Next, ONMIPA question facilitated critical thinking development. Although it does not have to be proven directly in the laboratory, the ONMIPA question requires that fact-based answers presented, which should answer using a logical, rational, or scientific method-based thinking process (ONMIPA Questions 2017, 2018, 2019). ONMIPA questions require participants to try to use scientific value or scientific attitudes to determine attitudes when dealing with natural phenomena or real-life problems that are relevant to natural science. The last, ONMIPA and science learning. The existence of ONMIPA expected to provide input and feedback for higher education circles to conduct self-evaluations about the quality of Mathematics and Natural Science learning in their respective colleges. Based on observation, ONMIPA has practical benefits as an effort to draw the quality of education in the country.

Also, ONMIPA motivates students to love Mathematics and Sciences, which will significantly benefit the future of Indonesia in terms of mastery of science and technology. It is time for us to think about what Makarim (2019) said that we should mainstream learning activities in which various competencies needed in life. Soft skills embedded in every lesson will hugely beneficial in creating superior Indonesian people who are Indonesian-born. Hopefully, this generation will move forward in the future in line with other nations with superior abilities to compete and collaborate in the era of universally that we have now lived.

Participant Responses to the Implementation of ONMIPA

Besides describing the administration of ONMIPA in developing high order thinking skills, this study also examined participants' responses towards the administration of ONMIPA. The responses from participants are valuable sources of information in various aspects. As stated by Van der Kleij et al. (2019) that reviews have evolved towards a student-centered perspective, with increased recognition of students as active agents in their learning and interaction with feedback.

Feedback provides crucial influence in teaching-learning activity as it gives information for learning development in many aspects. The findings of recent studies well support the statement in line with Georgeta (2019) opinion that quality teaching directly related to useful and high-quality feedback and such arguments. Feedback constitutes a central aspect of learning, yet has been largely neglected in research to date, particularly from the student's point of view.

The results of the questionnaire utilize as evaluation and information about participants'

interests towards the administration of ONMIPA. The information gained, among others: the motivation behind the participation of participants in ONMIPA, information about the reputation of ONMIPA from the participants' perspective, and the benefits the participants' gained from participating in ONMIPA. Participant responses obtained through an online questionnaire given to participants via the Google form. Explicitly, the following are participants' responses towards the administration of ONMIPA.

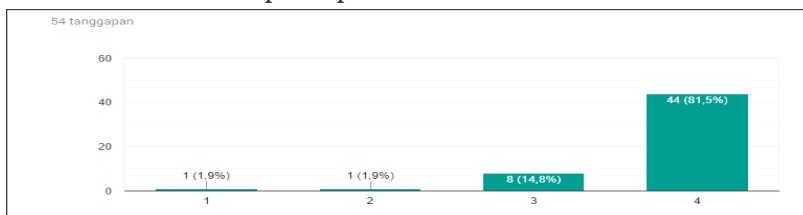


Figure 3. Diagram of Participation in ONMIPA

Figure 3 reveals that as many as 81.5% of participants said that they participated in ONMIPA activities of their own will. Students' willingness to participate is a form of self-motivation (internal influence). Internal influence plays a significant role in a student's success in learning and achieving his goals. As stated by Pintrich & De Groot (1990) in Liu et al. (2014) that to be successful in a learning situation, students need

to have both the 'will' and the 'skill' for learning. 'Will' in learning corresponds to the motivation of the learner, while the 'skill' pertains to the use of strategies that are effective for learning. The "will" is an internal motivation that can move someone to become successful. Besides, there are other factors, namely, external factors that can foster motivation. The situation shows in the diagram below.

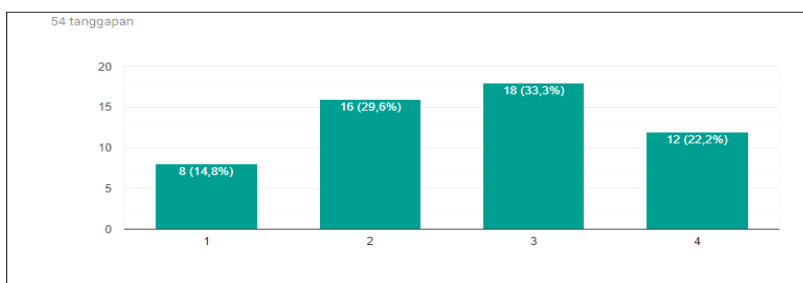


Figure 4. Diagram of Motivation in Participating ONMIPA

Figure 4 provides information that 33.33% of participants agreed that the ONMIPA prize was the main attraction, whereas the others stated that they have other motives. Referring to the opinion of Pintrich & De Groot (1990) in Liu et

al. (2014), the reason given by most participants listed in the diagram above is also one of the wills, which is motivation. In this case, external motivation.

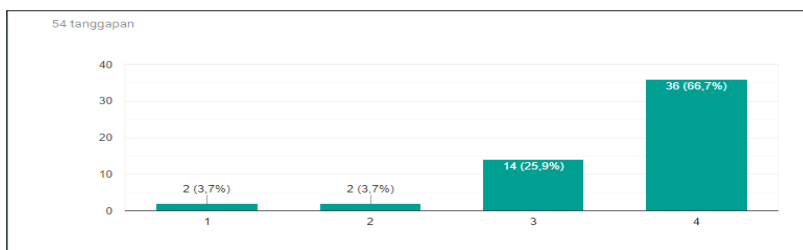


Figure 5. Diagram of Participants' Perception of ONMIPA

Figure 5 shows the participants' perceptions of ONMIPA activities. 66.7% of the partici-

pants strongly agree that ONMIPA is a prestigious competition.

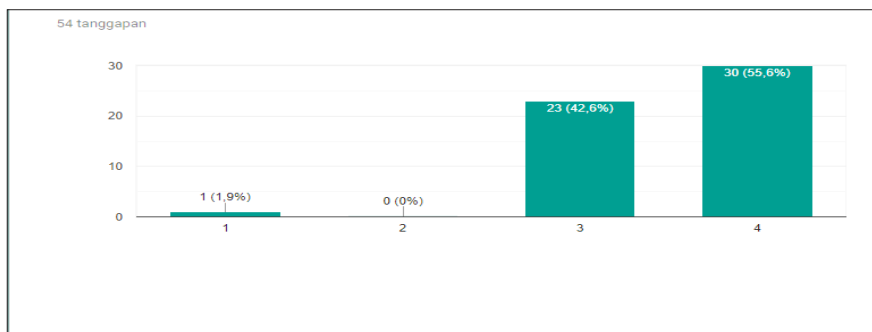


Figure 6. Diagram of Learning Motivation in ONMIPA

Figure 6 provides information that, in addition to interest in prizes, it turns out that the implementation of ONMIPA itself is an external motivational factor. The existence of external motivation factors shown as the effect of the implementation of ONMIPA, in which 55.6% of participants are motivated to learn.

From the two diagrams above, the researcher concluded that participants who attend ONMIPA should have competence in their fields, also have high internal and external motivation. This high motivation, supported by their competency, makes students motivated to get higher academic achievement.

Students' motivation in getting higher academic motivation corresponds with Wang et al. (2019) opinion that when students are highly motivated, they tend to stay engaged and persist longer. Moreover, students will acquire knowledge in more coherent forms, apply their knowledge more often, and achieve higher academic performance over the long term. Wang et al. (2019) also state that for decades, researchers have established the connection between students' motivation and many positive learning effects.

Beside obtained in the form of a Likert scale, participant responses also gained regarding the benefits derived from participating in ONMIPA in the form of a short essay.

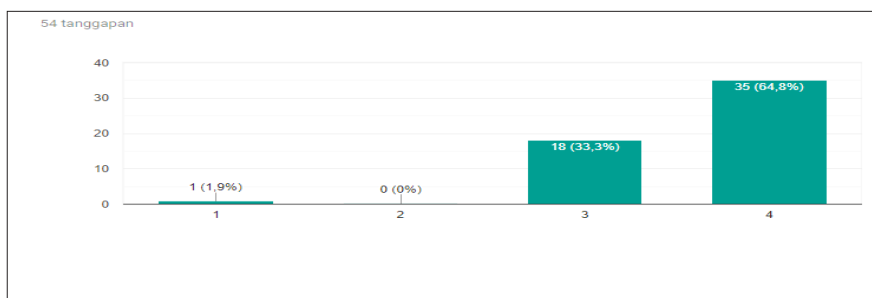


Figure 7. Diagram of Benefits of Participation in ONMIPA

In addition to increasing motivation in learning and a desire to get higher academic achievement, participants also respond that they get many benefits with their participation in ONMIPA, as shown in Figure 7. From the various answers given, most responses are as follows.

Students' increased motivation and enthusiasm for learning also influenced by other participants. By following ONMIPA, students having the awareness to manage time more effectively. Moreover, students' participation in ONMIPA growing network and relations from various universities. Others benefit from the students'

participation in ONMIPA are adding experience in participating in competitions and insights; like self-actualization; raising self-assessment; and way of self benchmarking. Participants also respond that by following ONMIPA, they train their analytical power, enhance competitive spirit, and spur hard work in learning & achieving.

From the various responses given by students, it appears that activities outside the classroom (in this case participation in the competition) increase motivation and lead to better educational outcomes. The situation in line with the opinion expressed by Hagger and Hamilton

(2018) that one possible mechanism by independent support in the classroom environment leads to better educational outcomes is through greater autonomous motivation toward and participation in learning activities outside of class.

Furthermore, the participation of students in the competition can also classify as an effort to improve student assessment processes with curricular activities and goals, interests, and personal experiences that are valued, as well as personal experiences. Albrecht & Karabenick (2018) assert that a primary goal of relevance interventions is to scaffold students' appraisal processes that connect curricular activities and valued goals, interests, and personal experiences.

Institution Support for the Administration of ONMIPA

This section discusses the support provided by institutions for student participation in ONMIPA. Some issue that discussed regarding the support provided by participants' institutions, preparations arrange before the competition, selection of participants, and forms of appreciation given to ONMIPA participants. As Muhardi (2019) affirm that integrated effort among students, lecturers, and university institutions is the crucial factor of university competitiveness.

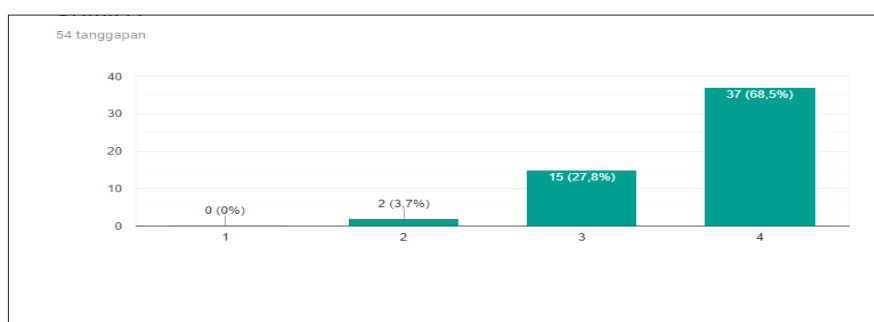


Figure 8. Diagram of Institution Support for Student Participation in ONMIPA Activities

From Figure 8, most of ONMIPA participants (68.5%) strongly agree that the university where they study provides adequate support in many ways. Only a small portion, namely 3.7%

of ONMIPA participants, felt that support from tertiary institutions from where they came from, was insufficient.

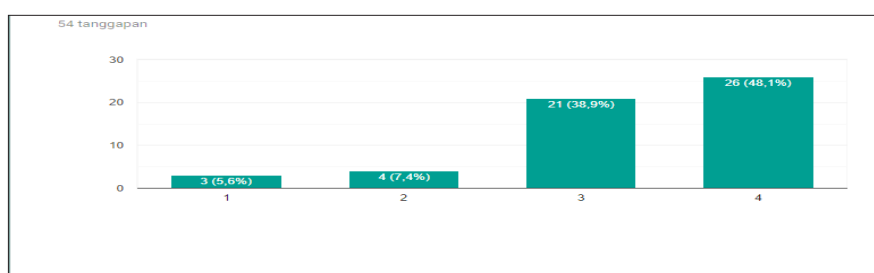


Figure 9. Diagram of ONMIPA Preparations Held by Institution

From Figure 9, we can examine participants' responses regarding the preparation done by the institution in facing ONMIPA after knowing that their students enter the national level. 48% gave responses that the campus gave preparation before the competition held. Meanwhile, 38,9% of participants agreed with the statement that the campus held a preparation before the competition held. Consolidation carried out differently in each institution. Some institution holds practi-

ce questions session long before the competition begins. Some institutions prepare by arranging quarantine a week before the competition and in the form of both camping preparation. The remaining 7.4% and 5.6% or around 7 participants disagreed with the statement. Participants who did not agree with the statement, in other words, saying that their tertiary institution did not hold preparation before the competition. In this case, the participants made independent preparations.

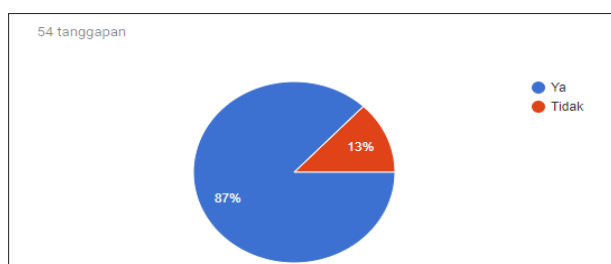


Figure 10. Diagram of Selection of ONMIPA Participants in Institution

Figure 10 presents the selection of participants before attending ONMIPA. Of the 54 participants who responded, 87% or 47 participants of ONMIPA said that their institution held a selection process in selecting participants. It means that prospective participants register to participate in the selection. Then similar competitions are held at the university level, after which the winners of

the university level competition are sent to the regional level to then compete in the region and continue to the national level. The 13% or 7 participants did not agree with the statement that the campus held a selection for ONMIPA. It means that the university has data about students who have the ability in the fields contested in ONMIPA and make direct appointments.

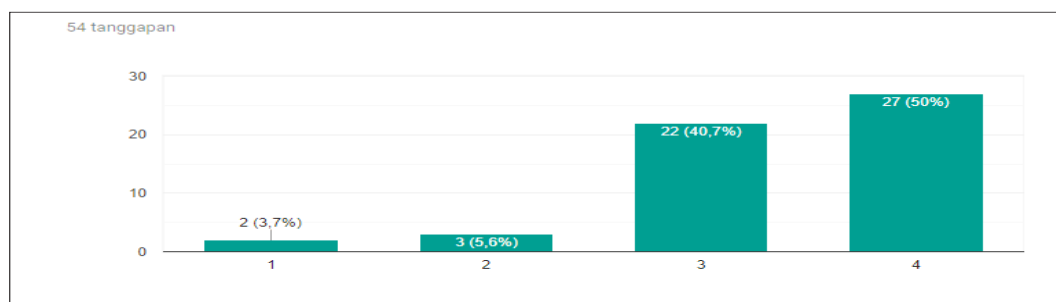


Figure 11. Diagram of Appreciation of Institution towards ONMIPA Participants

From Figure 11, we can see that regarding institution appreciation of ONMIPA participants, 50% or 27 participants strongly agreed with the statement, and 40.7% or 22 people agreed with the statement that institution gave appreciation for students who participate in ONMIPA. As for only about 5.6% or three people, and 3.7% or two people who disagree and strongly disagree with the statement that the campus gives appreciation to ONMIPA participants.

The appreciation given is in the form of prize money, other incentives, scholarships, and award certificates. Even some universities did celebration and install banners if their students win the competition. Appreciation gave by the institution classified as a reward in the world of education that motivates students to continue to do their best. It is a form of external motivation. Individual motivated for a different reason, it could be intrinsic or extrinsic motivation Levesque et al. (2010). In his research, Costica (2013) convince that there are two types of motivation - internal

and external. Intrinsic motivation means one like what s/he doing for its own sake, whereas extrinsic motivation means one does something as a means to an end - in order to get a reward. Furthermore, Jovanovica & Matejevic (2014) affirm that external and internal motivation improve students' creative achievement.

CONCLUSION

Based on the findings and discussion above, it can be concluded that The National Mathematics and Sciences Olympiad or ONMIPA have great potential to develop students' critical thinking skills reflect in several ways, among others: competition factor, raising concept attainment, form, and question on ONMIPA test, the fact that MIPA's material itself requires higher-level thinking skills to understand. It also because the questions tested are in addition to having medium and challenging levels of difficulty in the Bloom Cognitive domain.

Furthermore, participants' responses to the administration of ONMIPA were very positive. It motivates students to study harder in the field of mathematics and sciences, build and strengthen social networking and nation cohesiveness, even participate in ONMIPA was very encouraging, especially if they succeeded in becoming champions. Besides, some expected things that were of a natural material, for example, scholarships or other rewards. Higher education support to participants and the organization of ONMIPA is generally excellent even though the content and form are very diverse. For example, by carrying out a preliminary selection in each university, support for participation in ONMIPA and rewards for students they send. Higher education also uses ONMIPA as feedback for improving the quality of learning in their environment, even for ministries, the implementation of ONMIPA is useful for mapping and equalizing the quality of education.

REFERENCES

- Abernathy, T.V., & Vineyard, R.N. (2001) Academic competition in Science: What are the reward for students?. *The Clearinghouse*, 74(5), 269-276.
- Alatas, F. (2014). Hubungan pemahaman konsep dengan keterampilan berpikir kritis melalui model pembelajaran treffinger pada mata kuliah fisika dasar. *EDUSAINS*, 6(1), 87-96.
- Albrecht, J. R., & Karabenick, S. A. (2018) Relevance for Learning and Motivation in Education. *The Journal of Experimental Education*, 86(1), 1-10.
- Badan Pusat Statistik (BPS). (2018). *Indonesia Unemployment Rate*.
- Bappenas. (2019). *Human Capital Development*. Menuju Pembentukan Manajemen Talenta Nasional. Jakarta 20 Mei 2019
- Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., & Galindo-Domínguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher's view. *Thinking Skills and Creativity*, 33, 100584.
- Costica, S. E. (2013). About rules, punishments, and rewards in education. *Procedia - Social and Behavioral Sciences*, 112, 1160-1166.
- Critical Thinking of Students – Indicator of Quality In Higher Education. *Procedia - Social and Behavioral Sciences*, 191, 591 -596.
- Ennis, R. H., & Norris, S. P. (1990). Critical thinking assessment: Status, issues, needs. *Cognitive assessment of language and math outcomes*, 36(1).
- Facione, P. (2015) *Critical Thinking: What It Is and Why It Counts*. Article January 2015 <https://www.researchgate.net/publication/251303244>
- Firman, H & Tola. B. (2008). The Future of Schooling in Indonesia. *Journal of International Cooperation in Education*, 11(1), 71-84.
- Fraenkel, J.R., Wallen, N.E., & Hyun, H.H. (2012). *How to Design and Evaluate Research in Education*. 8th Edition. New York. Mc Graw-Hill.
- Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational Research An Introduction Seventh Edition*. Boston: Longman.
- Georgeta, A. (2019). The Value of Students' Feedback. *MATEC Web of Conferences* 290, 13006.
- Gojkov, G., Stojanovic, A., & Gojkov, A. (2015). Critical Thinking of Students – Indicator of Quality In Higher Education. *Procedia - Social and Behavioral Sciences*. 191 (2015) 591 -596.
- Guilmette, M., Mulvihill, K., Villemare-Krajden, R., Barker, E. T. (2019). Past and Present Participation in Extracurricular Activities is Associated with Adaptive Self-Regulation of Goals, Academic Success, And Emotional Wellbeing Among University Students. *Learning and Individual Differences*, 73, 8-15.
- Hagger, M. S., & Hamilton, K. (2018). Motivational predictors of students' participation in out-of-school learning activities and academic attainment in science: An application of the trans-contextual model using Bayesian path analysis. *Learning and Individual Differences*, 67, 232-244.
- Haviz, M., Karomah, H., Delfita, R., Umar, M. I. A., & Maris, I. M. (2018). Revisiting generic science skills as 21st century skills on biology learning. *Jurnal Pendidikan IPA Indonesia*, 7(3), 355-363.
- Hinduan. A. A. (2001). *The Development of Teaching And Learning Science Models at Primary School and Primary School Science Teacher Education* (Thesis, UPI Bandung). <https://www.ceicdata.com/en/indicator/indonesia/unemployment-rate>.
- Jovanovica, D., & Matejevic, M. (2014). Relationship between Rewards and Intrinsic Motivation for Learning. *Social and Behavioral Sciences*, 149, 456-460.
- Kelly, M., Sonert, G., & Sadlet, P. (2018). The influence of students' participation in STEM competition on their interest in STEM career. *International Journal of Science Education. Part B: Communication and public engagement*, 8(2), 95-114.
- Kemenristekdikti. (2019). Panduan Pelaksanaan ONMIPA 2019.
- Kuech, R., & Sanford, R. (2014). Academic Competitions: Perceptions of Learning Benefits from A Science Bowl Competition. *European Scientific Journal*, 1, 388-394.
- Levesque, C., Copeland, K. J., Pattie, M. D., & Deci, E. L. (2010). Intrinsic and extrinsic motivation. Missouri State University, Springfield. Available online at <https://www.docdroid.net/8i4s/intrinsic-and-extrinsic-motivation.pdf>
- Liu, W. C., Wang, C. K. J., Kee, Y. H., Koh, C., Lim, B. S. C., & Chua, L. (2014). College students' motivation and learning strategies profiles and academic achievement: A self-determination theory approach. *Educational Psychology*, 34(3), 338-353.

- Makarim, N. (2019). *Speech at Coordination Meeting of the Ministry of Education and Culture*. Jakarta. *Menuju Pembentukan Manajemen Talenta Nasional*. Jakarta 20 Mei 2019.
- Muhardi. (2019). *Keterpaduan unsur lembaga, dosen dan mahasiswa pada perguruan tinggi*. Bandung: Unisba.
- Mykhailyshyn, H., Kondur, O., & Serman, L. (2018). Innovation of Education and Educational Innovations in Conditions of Modern Higher Education Institutions. *Journal of Vasyl Stefanyk Precarpathian National University*, 5(1), 9-16. ONMIPA 2019.
- Pradana, F. A., Suyatna, A., Ertikanto, C., & Herlina, K. (2019). The Development of an Electronic Book on Quantum Phenomena to Enhance Higher-Order Thinking Skills of the Students. *Journal of Physics: Conference Series*, 1155(1), 012012.
- QS World University Ranking. (2020). Retrieved January, 2020 . Available online at <https://www.topuniversities.com/university-rankings>
- Rahmawati. (2016). *Seminar Hasil TIMSS 2015: Diagnosa hasil untuk perbaikan mutu dan peningkatan capaian*. Available online at <http://puspendik.kemdikbud.go.id>.
- Raths, L. E. (1967). *Teaching for thinking: Theory, strategies, and activities for the classroom*. Teachers College Press.
- Roessingh, H., & Chambers, W. (2011). Project-Based Learning and Pedagogy in Teacher Preparation: Staking Out the Theoretical Mid-Ground. *International Journal of Teaching and Learning in Higher Education*, 23(1), 60-71.
- Rustaman, N. (2002). *Pandangan Biologi Terhadap Proses Berfikir dan Implikasinya dalam Pendidikan Science*. Pengukuhan jabatan Guru Besar Tetap dalam Bidang Ilmu Pendidikan Biologi FPMPA UPI. Bandung: UPI.
- Tjalla, A. (2019). *Potret Mutu Pendidikan Indonesia Ditinjau dari Hasil-hasil Studi Internasional*. FIP UNJ. (Accessed on May, 18 2019)
- Van der Kleij, F. M., Adie, L. E., & Cumming, J. J. (2019). A meta-review of the student role in feedback. *International Journal of Educational Research*, 98, 303-323.
- Wahidin, D. (1993). *Kemampuan Melakukan Penalaran Ilmiah dan Kemampuan Melakukan Elaborasi Untuk Memahami Konsep-Konsep Lingkungan Hidup*. (Thesis, IKIP Bandung).
- Wahidin, D. (2019). *Kemerdekaan Belajar Mahasiswa Menuju SDM Unggul dan Kompetitif untuk Indonesia Maju*. Speech at Annual Meeting for Vice Rector of Students' Affairs. Ditmawa Ditjen Belmawa Kemenristekdikti, Jakarta 2019.
- Wang, C. J., Liu, W. C., Kee, Y. H., & Chian, L. K. (2019). Competence, autonomy, and relatedness in the classroom: understanding students' motivational processes using the self-determination theory. *Heliyon*, 5(7), 01983.
- Webometrics. (2019). *Ranking Web of Universities*. retrieved December 2019 at <http://www.webometrics.info/en/Asia>. 2019).
- WIPO Statistic Database. (2017). *World Intellectual Property Indicators*. retrieved November, 2019 at https://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2017.pdf
- Wong, L.P. (2008). Data Analysis in Qualitative Research: A Brief guide using Invivo. *Malays Fam Physician*, 3(1): 14-20.