International Journal of Evaluation and Research in Education (IJERE)
Vol. 12, No. 3, September 2023, pp. 1637~1644
ISSN: 2252-8822, DOI: 10.11591/ijere.v12i3.25078

Environmental supplement book of flood disaster for university students

Ilmi Zajuli Ichsan[1,2], Agung Purwanto[1], Henita Rahmayanti[1]
[1]Doctoral Program of Population and Environmental Education, Postgraduate Program, Universitas Negeri Jakarta, Jakarta, Indonesia
[2]Elementary Teacher Education, Faculty of Teacher and Education, Universitas Mohammad Husni Thamrin, Jakarta, Indonesia

Article Info

Article history:

Received Jul 27, 2022
Revised Mar 5, 2023
Accepted Jun 1, 2023

Keywords:

Higher order thinking skills
Pro-environmental behavior
Supplement book
University students

ABSTRACT

Solving natural disaster problems, especially floods, requires community participation. One of the efforts that can be done is by implementing the environmental supplement book of flood disasters based on innovation learning model for natural science and environmental learning (ILMIZI). The purpose of this research was to implement a supplementary book to improve university students' higher order thinking skills (HOTS) and pro-environmental behavior (PEB). This was an experiment method consisting of experimental class and control class. The samples were 115 university students with 60 university students in experimental class and 55 university students in control class. The data analysis was a t-test that aims to test the significance of the difference in the mean HOTS and PEB scores for the experimental class and the control class. In addition to the t-test, descriptive analysis was also carried out by comparing the HOTS and PEB scores between the experimental class and the control class. The results of this study indicated that the t-test results were significant, which means that supplement books could increase HOTS and PEB of university students. The results of the descriptive analysis showed that university students were still weak in flood mitigation efforts related to the provision of disaster evacuation tools. In an effort to prevent disasters, it was necessary to innovate environmental learning to support sustainability. A conclusion can be drawn that the use of supplementary books can increase university students' HOTS and PEB.

Corresponding Author:

Ilmi Zajuli Ichsan
Doctoral Program of Population and Environmental Education, Universitas Negeri Jakarta
Rawamangun Muka st., East Jakarta, Indonesia
Email: ilmizajuli95@gmail.com

1. INTRODUCTION

Disaster problems that occur in various rural and urban areas become the focus of problems that must be resolved. Disasters such as floods, landslides, and forest fires have a negative impact on human life. One of the disasters that often occur is related to flooding. Flooding is a disaster caused by various factors, namely human factors and natural factors [1]–[3]. Many incidents related to flooding occur due to low public awareness of preserving the environment. The low public awareness causes difficulty to execute various environmentally friendly programs, especially for urban areas to support sustainability. The participation of various components of society, including university students, is indispensable in preventing disasters.

University students are components of society that have an important role in preventing environmental damage. They are expected to be actively involved in preventing flood problems with various activities such as counseling, seminars, socialization of flood mitigation equipment, and other activities.

The flood problem will be solved if university students actively help and are maximally involved in solving the problem [4]–[6]. The ability to solve this problem is required in the form of higher order thinking skills (HOTS). University students must be able to solve problems and provide solutions to these problems. According to Anderson [7], HOTS consists of three aspects, namely analyze (C4), evaluate (C5), and create (C6). HOTS needs to be trained continuously to make these skills more mastered. The university students must have good behavior towards the environment or known as pro-environmental behavior (PEB). Various forms of PEB are observable when university students can implement them in the form of daily activities to support sustainability. PEB is influenced by various factors, one of them is related to environmental education conducted at the university level.

Various studies have been carried out related to educational innovation; likewise, the development of learning models for the field of science, such as the orientation, identify, discussion, decision, and engage in behavior (OIDDE) model [8]. The results of these development activities indicate that the OIDDE model is feasible to be used in biology learning to improve higher order thinking skills. In addition, the development of a reading, mind mapping, and sharing or known as RMS model that is oriented towards strengthening scientific literacy has been conducted [9], [10]. This model will also greatly support the various ideas of students at various levels of education in schools and universities. In addition to the OIDDE and RMS models development, the innovation learning model for natural science and environmental learning (ILMIZI) model is also developed that is oriented towards solving environmental problems, especially based on HOTS aspect. The ILMIZI model was developed to strengthen environmental learning standards to be oriented towards problem solving [11].

In addition to the learning model, previous research that has been done is related to the development of learning media based on android applications. The digital learning media developed are very useful and help university students to study remotely, especially during the corona virus disease 2019 (COVID-19) pandemic. During the COVID-19 pandemic, all learning has changed to e-learning [12]–[15]. The pandemic has triggered the benefit of using android as a learning medium. This is due to the learning that uses smartphones and is conducted using an e-learning system that is used remotely. This update will be very useful in conveying various environmental content that needs to be delivered to university students.

In addition to the utilization of android, numerous developments related to websites occurred that are used for learning science and the environment [16]. The purpose is so that various information can be absorbed by students and university students in more depth. Therefore, the research has developed a book called environmental supplement book of flood disaster based on ILMIZI. This book innovation is an alternative learning medium that can be used to improve PEB. The media was developed aiming at providing broader knowledge related to flood mitigation. Based on the description, it is deemed necessary to implement the environmental supplement book of flood disasters based on science to improve university students' PEB This research goal was to implement the environmental supplement book of flood disasters based on ILMIZI to improve university students' HOTS and PEB.

2. RESEARCH METHOD

The study used an experimental method involving a control class and a treatment/experimental class. The study was conducted from July to October 2021. The treatments were pre-test, treatment with media, and post-test. The ILMIZI model is an innovative learning model developed by Ichsan [11]. This model is a development and renew of various learning models that have existed before such as problem-based learning, project-based learning, and discovery learning. Figure 1 shows the learning steps and activities/syntax of lecturers and university students in learning using the ILMIZI model.

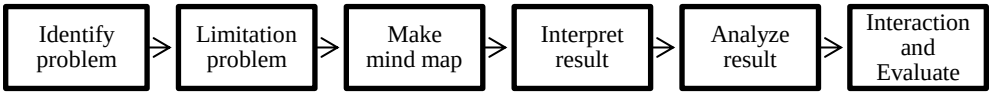

Figure 1. ILMIZI learning model syntax

ILMIZI learning model is an innovation for natural science and environmental education. Figure 2 illustrates the developed environmental supplement books based on ILMIZI. The book has been integrated with the ILMIZI model. The stages in each part of the book have a command/syntax stage from the ILMIZI model that can be implemented in learning. The implementation of the ILMIZI learning model is integrated with the use of the learning book.

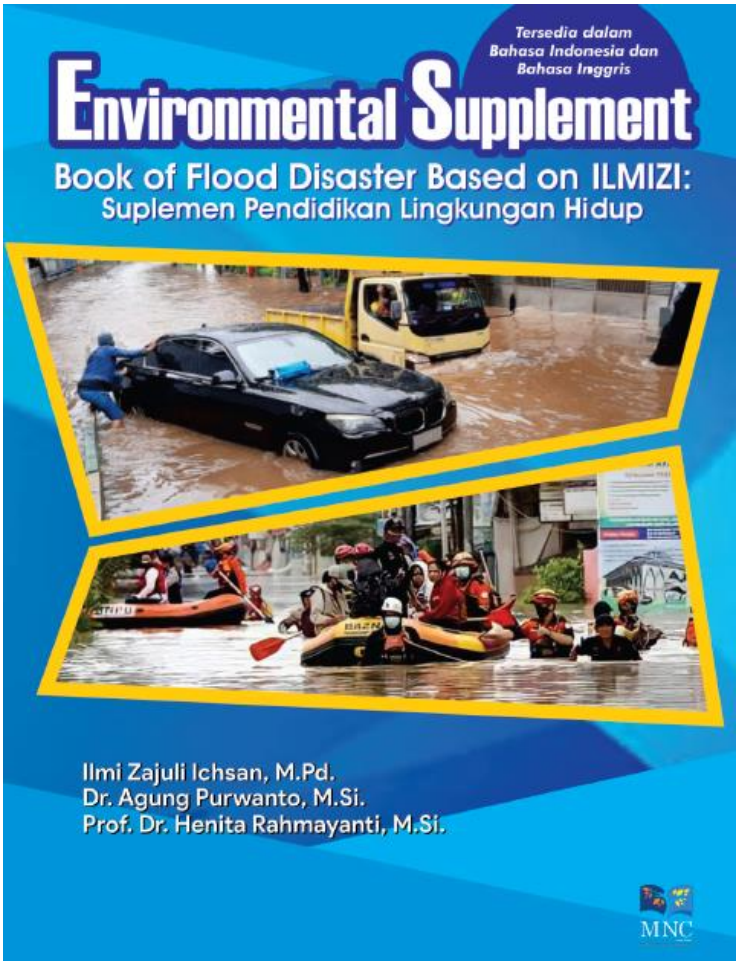

Figure 2. Environmental supplement book of flood disaster based on ILMIZI [17]

The samples comprised of university students from East Jakarta City, Indonesia. The samples were randomly selected using a simple random sampling technique. The sampling resulted 115 university students consisting of 60 university students for the experimental class and 55 university students for the control class. The samples research were university students from faculty of mathematics and natural science. They were also from elementary teacher education program. The samples have same character because they have been studied environmental education in their course before.

The higher order thinking skills instrument developed based on the research by Anderson [7]. The indicator consists of three aspects, namely analyze (C4), evaluate (C5), and create (C6). The instrument made consists of six indicators which are then further developed into 12 items (score scale from 0 to 10 for each item). The PEB instrument was carried out using the PEB instrument developed based on the Kaiser and Wilson [18] that consists of six main aspects, namely energy efficiency, transportation, waste avoidance, consumerism, recycling, and social behavior. The six aspects that became indicators of the PEB instrument developed were 25 items containing statements related to flood prevention efforts in their surrounding environment (score scale from 1 to 5 for each item).

The validity test used is Pearson product moment. All the items developed; the results show that all items used in this study have valid categories. The reliability of the instrument was measured using the Spearman Brown formula. The results showed that the reliability of the instrument for HOTS was 0.75 and the reliability of the PEB instrument was 0.86. It could be categorized as a reliable instrument. This instrument can be used for research because all items were valid and reliable.

Upon the completion of the post-test measurement, the next step was performing a t-test to compare the scores between the control class and the experimental class. The results of the t-test were then interpreted as a form of the results of the differences in the treatment given. Apart from the t-test, a descriptive analysis was performed for all scores related to PEB in a tabular form. Descriptive analysis were employed to explain in details about data.

3. RESULTS AND DISCUSSION

The study results indicate that the scores of normal and homogeneity were normally distributed and homogeneous. Normality test and homogeneity test were important before using t-test. The study shows the results of the t-test for HOTS of 5.62 and a sig. value of 0.000 which can be seen in Table 1. Thus, it proceeded with a t-test that resulted for PEB in a value of sig 0.019, which was sig<0.05; so that the results of the t-test were significant. Mean difference of this t-test was 5.28 and t-value higher than t-table. The details of the t-test results are can be seen in Table 2.

Table 1. The t-test results university students' HOTS scores

t-value	t-table	df	Sig	Mean difference
5.62	1.65	113	0.000	11.96

Table 2. The t-test results of the PEB university students' scores

t-value	t-table	df	Sig	Mean difference
2.37	1.65	113	0.019	5.28

The results of the study showed that the university students' HOTS scores based on each indicator had the highest score on the 1st indicator for the experimental and control classes. Meanwhile, the lowest result is found in the 6th indicator related to the ability to create problem solutions. This average score indicates that the HOTS of the experimental class students is higher than the control class. The scores are presented in Table 3.

Table 3. Average HOTS score based on indicators

No	Aspect	Indicators	Experimental	Control
1	Analysis (C4)	Analyze the causes of the large amount of waste that causes flooding in urban areas	3.88	2.71
2	Analysis (C4)	Analyze various problems related to waste	3.71	2.54
3	Evaluate (C5)	Provide views related to efforts to prevent flood disasters	3.65	2.31
4	Evaluate (C5)	Provide criticism related to the use of paid plastic	3.63	2.59
5	Create (C6)	Provide innovative ideas related to disaster mitigation efforts	3.57	2.26
6	Create (C6)	Create a solution related to environmental conservation programs that are less effective	3.48	2.33

Regarding the descriptive analysis, the results show that the average score of the experimental class was higher for all indicators as seen in Table 4. The results of the study indicate that the use of the environmental supplement book of flood disaster based on ILMIZI had a significant impact on increasing the university students' PEB. The results of this study indicate that the highest average score was on the 3rd indicator, namely waste avoidance.

Table 4. Average PEB score based on indicators

No	Indicators	Experimental	Control
1	Energy efficient	3.55	3.33
2	Transportation	3.07	2.79
3	Waste avoidance	4.32	4.15
4	Consumerism	4.16	3.88
5	Recycling	3.88	3.53
6	Social behavior	3.59	3.32

The lowest HOTS score is on the 11th item for the experimental class. Meanwhile, the lowest score from the control class is on the 10th item. The highest score for experimental class was in 4th item. Then highest score for control class was in 1st item. This shows that the types of questions included in the create aspect (C6) are still difficult for university students to answer. Table 5 displays the results of average HOTS score for each item.

Table 5. Average HOTS score for each item

No	Item	Experimental class	Control class
1	In your opinion, how to solve the problem of flooding in urban areas, please provide the results of your analysis regarding this in terms of community vulnerability to flooding.	4.07	2.91
2	Give an analysis related to this that causes people to not want to recycle.	3.68	2.51
3	Give your analysis why people who are vulnerable to flooding still litter?	3.33	2.55
4	Make a systematic analysis related to the function of AMDAL to protect the environment.	4.08	2.53
5	Provide views related to sustainable development that is difficult to realize in everyday life, especially in terms of disaster mitigation, and especially related to flooding.	3.88	2.38
6	What evaluations can be done by students to support the efforts of sustainable development programs to prevent environmental pollution?	3.42	2.24
7	Give a critique of the behavior of people who can still carry plastic as a container for food.	3.77	2.35
8	Give criticism and suggestions related to the policy of using paid plastic bags.	3.50	2.84
9	As a student, create a problem solution that can be done to overcome the problem of low public awareness of the environment.	3.78	2.36
10	Give an innovative idea based on technology so that people want to mitigate flood disasters.	3.35	2.16
11	Provide innovative solutions so that these regulations can be implemented and adhered to in the context of flood disaster mitigation.	3.25	2.33
12	Make a simple program to overcome the problem of the lack of student awareness to reduce the impact of flood disasters in urban areas.	3.72	2.33

The results of further descriptive analysis of the average PEB scores of the experimental class and control class for each item are presented in Table 6. The study results indicate that the lowest average score was found in the 7th item related to mitigation efforts by setting up a rubber boat. The highest score was in 24th item for experimental and control class. Average score of this PEB of each item in Table 6 shows that PEB score can be improve by this supplement book.

Table 6. Average PEB score for each item

No	Item	Experimental class	Control class
1	I prepared a backup energy source in case of a power outage during floods.	3.10	2.69
2	I always provide a power bank to keep my Smartphone on in anticipation of contacting the evacuation team when floods come.	3.35	3.42
3	I install energy-efficient electrical equipment and place it in a place that is safe from flooding.	3.83	3.36
4	I avoid putting electronic devices in low areas.	3.93	3.85
5	I monitor areas that have the potential to flood before leaving for travel.	3.48	3.20
6	I choose to use public transportations instead of private vehicles to facilitate flood disaster mitigation.	3.53	3.73
7	I prepare an inflatable boat to anticipate the flood that might come at any time.	1.92	1.25
8	I use GPS while driving to avoid flooded areas.	3.33	2.96
9	I reuse waste paper that can still be used to avoid clogging the drains.	3.87	3.56
10	I use paper back and forth to save money as an effort to mitigate disaster and environmental pollution.	4.52	4.51
11	I choose to use cloth to clean the house to avoid environmental pollution due to using disposable tissues.	4.47	4.31
12	I prefer to use a tumbler (refillable drinking bottle) to minimize plastic waste.	4.42	4.20
13	I use my personal cloth tote bag for shopping.	4.65	4.44
14	I buy products marked as eco-friendly to avoid pollution and disasters.	3.90	3.51
15	When I travel, I bring a refillable bottle from home to reduce plastic waste.	4.20	4.09
16	I avoid buying food in styrofoam because it pollutes the environment.	3.88	3.47
17	I buy recycled goods because it supports going green and flood mitigation efforts.	3.55	3.11
18	I sort out various organic wastes and plastic wastes to minimize the impact of the flood disaster.	3.65	3.29
19	I avoid throwing trash in public places where there are no trash cans.	4.63	4.40
20	I prefer to use used cans to minimize plastic waste.	3.70	3.33
21	I take part in cleaning waterways in the neighborhood around the house with health protocols.	3.35	3.00
22	I invite the public to do flood disaster mitigation through social media.	3.05	2.75
23	When I get home, I will try to clean it and dispose of the trash according to its category.	3.78	3.25
24	If a friend asks me to throw trash in the river, then I will refuse.	4.78	4.75
25	I participate in environmental seminars/webinars to support flood disaster mitigation efforts.	3.00	2.84

Based on the results of the study, it can be seen that the HOTS score of university students has increased. This indicates that supplementary books that have been integrated with the ILMIZI model can improve the ability of HOTS university students. This is because the various activities in the book support university students to practice HOTS abilities. Such as activities in the form of worksheets in the supplement book. University students will be familiar with the various assignments on the worksheets that support orientation towards the ability to analyze flood problems. This analytical ability will be accompanied by evaluation capabilities that can be used to provide criticism of various phenomena that occur. Lastly the ability to create innovation. This ability is very relevant to the development of the 21st century related to the ability to think creatively [19]–[22]. University students who have the ability to think creatively will be able to come up with creative ideas to solve problems.

Environmental supplement book of flood disasters based on ILMIZI can be used for environmental learning at the university level. This is supported by the results of the t-test that shows a significant difference between the PEB scores of the experimental class and the control class. The results of this study also show that the implementation of student behavior in the form of PEB can be seen as a form to support sustainability. Behavior applied to prevent environmental damage will make sustainable development programs easier to implement [23]–[27]. The ILMIZI model integrated into the supplement book has a function to make learning activities orient towards solving complex environmental problems. The stages of analyzing the ILMIZI model are useful for training university students' abilities to find out what flood problems are and then implementing them in the form of PEB. The ILMIZI model facilitates the university students to be able to do and solve contextual problems.

In addition to the easiness of implementing various sustainable development programs, the implementation of PEB can concretely improve the ability of university students to solve environmental problems that exist around them. University students can develop various programs related to environmental disaster mitigation in the community. University students can form various disaster-response communities and empower the surrounding communities to provide education related to preventive efforts and evacuation efforts from floods. Various programs can be carried out on a regular basis so that changes gradually occur in the community. Thus, the programs can provide concrete solutions for the communities [28]–[32]. The solutions can be generated if the community as a whole already understands the various mechanisms that exist in the environment and is able to understand various current environmental phenomena caused by climate change, global warming, and environmental pollution. Therefore, it is directed that the community needs to overcome various damages that may occur.

In addition to educational efforts that can be done by university students in the community, the university plays an important role in continuously revitalizing its various curricula to support sustainability. The curriculum developed must accommodate environmental topics related to past disasters as a special study topic [33]–[36]. Courses such as disaster mitigation education will have a good impact on efforts for disaster prevention at the university level. Lack of environmental education has an impact on university students' weak understanding regarding natural disaster prevention thus making it difficult for them to perform educational efforts to the community. Learning media innovations related to flooding also need to be developed and should be more varied to assist in providing education that is more attractive to university students.

4. CONCLUSION

Based on the results of the current research, it can be concluded that the environmental supplement book of flood disaster based on innovation learning model for natural science and environmental learning (ILMIZI) can increase the higher order thinking skills and pro-environmental behavior of the university students. In addition, the descriptive analysis still found low scores related to the university students' HOTS according about creative (C6) aspect of university students. Then, PEB aspect that low in the evacuation efforts by providing rubber boats as evacuation equipment. Efforts to develop environmental learning media in the future must continue to be carried out so that flood mitigation efforts can be increased from various aspects. Therefore, the goal of the expected mitigation efforts is to change the behavior of the wider communities. So that flood disasters can be prevented and have no bad impact on sustainability. The limitation of this research is that this research is only carried out in the Jakarta (Indonesia) area, so that the conclusions drawn can only be generalized to the Jakarta area. In addition, another limitation is the use of media which is only in the mathematics and natural sciences program and elementary teacher education study programs, so that the results cannot be generalized to all study programs.

REFERENCES

[1] L. J. Weber *et al.*, "The Iowa watersheds project: Iowa's prototype for engaging communities and professionals in watershed hazard mitigation," *International Journal of River Basin Management*, vol. 16, no. 3, pp. 315–328, 2018, doi: 10.1080/15715124.2017.1387127.

[2] R. Bicksler, "The role of heritage conservation in disaster mitigation: a conceptual framework for connecting heritage and flood management in Chiang Mai, Thailand," *Urban Geography*, vol. 40, no. 2, pp. 257–265, 2019, doi: 10.1080/02723638.2018.1534568.

[3] R. Rachmawati and C. V. Budiarti, "Use of space and the need for planning in the disaster-prone Area of Code River, Yogyakarta, Indonesia," *Indonesian Journal of Geography*, vol. 48, no. 2, pp. 178–190, 2016, doi: 10.22146/ijg.17633.

[4] A. Derman, E. Sahin, and E. Hacieminoglu, "Does outdoor education make any difference in environmental literacy of pre-service classroom teachers?" *International Journal of Environmental & Science Education*, vol. 11, no. 15, pp. 8491–8506, 2016, [Online]. Available: http://www.ijese.net/makale/1098.html.

[5] S. Salman Ashraf, M. A. Rauf, and F. H. Abdullah, "A hands-on approach to teaching environmental awareness and pollutant remediation to undergraduate chemistry students," *Research in Science and Technological Education*, vol. 30, no. 2, pp. 173–184, 2012, doi: 10.1080/02635143.2012.698604.

[6] B. Surpless, M. Bushey, and M. Halx, "Developing scientific literacy in introductory laboratory courses: a model for course design and assessment," *Journal of Geoscience Education*, vol. 62, no. 2, pp. 244–263, 2014, doi: 10.5408/13-073.1.

[7] L. W. Anderson *et al., A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman, 2001.

[8] Husamah, D. Fatmawati, and D. Setyawan, "OIDDE learning model: Improving higher order thinking skills of biology teacher candidates," *International Journal of Instruction*, vol. 11, no. 2, pp. 249–264, 2018, doi: 10.12973/iji.2018.11217a.

[9] A. Muhlisin, H. Susilo, M. Amin, and F. Rohman, "Improving critical thinking skills of college students through RMS model for learning basic concepts in science," *Asia-Pacific Forum on Science Learning and Teaching*, vol. 17, no. 1, pp. 1–24, 2016, [Online]. Available: https://www.eduhk.hk/apfslt/download/v17_issue1_files/muhlisin.pdf.

[10] A. Buber and G. Unal, "The effects of learning activities based on argumentation on conceptual understanding of 7th graders about 'Force and Motion' unit and establishing thinking friendly classroom environment," *European Journal of Educational Research*, vol. 6, no. 3, pp. 367–384, 2017, doi: 10.12973/eu-jer.6.3.367.

[11] I. Z. Ichsan, "ILMIZI: Innovation learning model for natural science and environmental learning based on HOTS," *International Journal for Educational and Vocational Studies*, vol. 1, no. 6, 2019, doi: 10.29103/ijevs.v1i6.1640.

[12] R. Huish, "Global citizenship amid COVID-19: why climate change and a pandemic spell the end of international experiential learning," *Canadian Journal of Development Studies*, vol. 42, no. 4, pp. 441–458, 2021, doi: 10.1080/02255189.2020.1862071.

[13] M. B. Cahapay, "Ushering children with disabilities in the 'new normal' post-COVID-19 period: collective actions in the Philippines," *Disability and Society*, vol. 36, no. 1, pp. 145–150, 2021, doi: 10.1080/09687599.2020.1829557.

[14] J. Konig, D. J. Jager-Biela, and N. Glutsch, "Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany," *European Journal of Teacher Education*, vol. 43, no. 4, pp. 608–622, 2020, doi: 10.1080/02619768.2020.1809650.

[15] N. Tovstiga and G. Tovstiga, "COVID-19: a knowledge and learning perspective," *Knowledge Management Research and Practice*, vol. 19, no. 4, pp. 427–432, 2021, doi: 10.1080/14778238.2020.1806749.

[16] S. H. Nugraini, K. A. Choo, H. S. Hin, and T. S. Hoon, "Impact of e-AV biology website for learning about renewable energy," *Turkish Online Journal of Educational Technology*, vol. 12, no. 2, pp. 376–386, 2013.

[17] I. Z. Ichsan, A. Purwanto, and H. Rahmayanti, *Environmental supplement book of flood disaster based on ILMIZI: Environmental education supplement*. Malang: Media Nusa Creative (in Indonesian), 2021.

[18] F. G. Kaiser and M. Wilson, "Goal-directed conservation behavior: The specific composition of a general performance," *Personality and Individual Differences*, vol. 36, no. 7, pp. 1531–1544, 2004, doi: 10.1016/j.paid.2003.06.003.

[19] L. S. Almeida, L. P. Prieto, M. Ferrando, E. Oliveira, and C. Ferrándiz, "Torrance test of creative thinking: The question of its construct validity," *Thinking Skills and Creativity*, vol. 3, no. 1, pp. 53–58, 2008, doi: 10.1016/j.tsc.2008.03.003.

[20] A. Aisyah, K. Salehuddin, I. Aman, R. Yasin, and N. Mimiko, "Eliciting Elements of Higher Order Thinking Skills in the Higher Secondary Examination Question Structure in Japan and Malaysia," in *Proceedings of the Regional Conference on Science, Technology and Social Sciences (RCSTSS 2016)*, 2018, pp. 455–464, doi: 10.1007/978-981-13-0203-9_42.

[21] E. Istiyono, W. S. B. Dwandaru, R. Setiawan, and I. Megawati, "Developing of computerized adaptive testing to measure physics higher order thinking skills of senior high school students and its feasibility of use," *European Journal of Educational Research*, vol. 9, no. 1, pp. 91–101, 2020, doi: 10.12973/eu-jer.9.1.91.

[22] F. Saltan and O. Faruk, "Using blogs to improve elementary school students' environmental literacy in science class," *European Journal of Educational Research*, vol. 6, no. 3, pp. 347–355, 2017, doi: 10.12973/eu-jer.6.3.347.

[23] X. Du, W. Jian, Q. Zeng, and Y. Du, "Corporate environmental responsibility in polluting industries: Does religion matter?" *Journal of Business Ethics*, vol. 124, no. 3, pp. 485–507, 2014, doi: 10.1007/s10551-013-1888-7.

[24] A. M. M. Miller and S. R. Bush, "Authority without credibility? Competition and conflict between ecolabels in tuna fisheries," *Journal of Cleaner Production*, vol. 107, pp. 137–145, Nov. 2015, doi: 10.1016/j.jclepro.2014.02.047.

[25] L. Liu, Y. Hsu, and J. Lin, "Sustainable development analysis of design and manufacturing integration: A system dynamics approach," *Cogent Engineering*, vol. 6, no. 1, 2019, doi: 10.1080/23311916.2019.1682775.

[26] T. Y. Yu, T. K. Yu, and C. M. Chao, "Understanding Taiwanese undergraduate students' pro-environmental behavioral intention towards green products in the fight against climate change," *Journal of Cleaner Production*, vol. 161, pp. 390–402, 2017, doi: 10.1016/j.jclepro.2017.05.115.

[27] A. Kabadayi and F. Altinsoy, "Traditional and technological methods for raising pre-school children's awareness of environmental pollution for sustainability," *Discourse and Communication for Sustainable Education*, vol. 9, no. 2, pp. 134–144, 2018, doi: 10.2478/dcse-2018-0020.

[28] J. Xu and Y. Lu, "Towards an earthquake-resilient world: from post-disaster reconstruction to pre-disaster prevention," *Environmental Hazards*, vol. 17, no. 4, pp. 269–275, 2018, doi: 10.1080/17477891.2018.1500878.

[29] S. I. A. Dwiningrum, "Developing school resilience for disaster mitigation: a confirmatory factor analysis," *Disaster Prevention and Management*, vol. 26, no. 4, pp. 437–451, 2017, doi: 10.1108/DPM-02-2017-0042.

[30] M. H. Tsai, M. C. Wen, Y. L. Chang, and S. C. Kang, "Game-based education for disaster prevention," *AI and Society*, vol. 30, no. 4, pp. 463–475, 2015, doi: 10.1007/s00146-014-0562-7.

[31] I. Zelenika, T. Moreau, O. Lane, and J. Zhao, "Sustainability education in a botanical garden promotes environmental knowledge, attitudes and willingness to act," *Environmental Education Research*, vol. 24, no. 11, pp. 1581–1596, 2018, doi:

10.1080/13504622.2018.1492705.
[32] B. Takahashi and T. Selfa, "Predictors of pro-environmental behavior in rural American communities," *Environment and Behavior*, vol. 47, no. 8, pp. 856–876, 2015, doi: 10.1177/0013916514521208.
[33] G. Karaarslan and G. Teksöz, "Integrating sustainable development concept into science education program is not enough: we need competent science teachers for education for sustainable development-Turkish experience," *International Journal of Environmental and Science Education*, vol. 11, no. 15, pp. 8403–8425, 2016.
[34] D. Hooi Ting and C. F. Chin Cheng, "Measuring the marginal effect of pro-environmental behaviour: Guided learning and behavioural enhancement," *Journal of Hospitality, Leisure, Sport and Tourism Education*, vol. 20, pp. 16–26, 2017, doi: 10.1016/j.jhlste.2016.12.001.
[35] A. T. Kinslow, T. D. Sadler, and H. T. Nguyen, "Socio-scientific reasoning and environmental literacy in a field-based ecology class," *Environmental Education Research*, vol. 25, no. 3, pp. 388–410, 2019, doi: 10.1080/13504622.2018.1442418.
[36] H. E. Vidergor, "Effectiveness of the multidimensional curriculum model in developing higher-order thinking skills in elementary and secondary students," *Curriculum Journal*, vol. 29, no. 1, pp. 95–115, 2018, doi: 10.1080/09585176.2017.1318771.

BIOGRAPHIES OF AUTHORS

Ilmi Zajuli Ichsan was graduated from the Bachelor of Education at Biology Education study program in 2018. Then, graduated from the Masters in Education at the Biology Education Study Program in 2020 from Universitas Negeri Jakarta. When this article was written, he was a doctoral candidate in the Doctoral program of Population and Environmental Education, Universitas Negeri Jakarta, Indonesia. His research focus is on higher order thinking skills, research and development, and environmental learning. He can be contacted at email: ilmizajuli95@gmail.com.

Agung Purwanto is a Professor in Doctoral programs of Population and Environmental Education, Universitas Negeri Jakarta, Indonesia. He also has expertise in environmental chemistry and environmental education. Especially in Technology based in environmental learning. Scientific publications in highly reputable international journals and his research focuses on environmental and chemical education. He can be contacted at email: agungpurwanto@unj.ac.id.

Henita Rahmayanti is a professor who teaches in the Masters and Doctoral programs of Population and Environmental Education, Universitas Negeri Jakarta, Indonesia. Her research focuses on environmental sciences and education, especially in environmental disaster mitigation education. Scientific articles that have been published in both national journals and highly reputable international journals discuss smart trash, sustainable development, and environmental education. She can be contacted at email: henita.rahmayanti@unj.ac.id.