



Disaster preparedness behaviors in biology education: Knowledge of environmental disaster mitigation

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Article Information	ABSTRACT
Submitted: 2021-01-19 Accepted: 2021-04-24 Published: 2021-05-04	Environmental disaster was important issue to be solved. Current situation disasters such as flood, earthquake, tsunami, volcanoes and others could be happened. This study aimed to obtain information about the relationship between knowledge of disaster and preparedness behaviors and disaster preparedness behaviors. This research was a Sequential Explanatory combination research consisting of 2 variables, namely knowledge about disaster mitigation as an independent variable (X) and disaster preparedness behaviors as a dependent variable (Y). This research was conducted in January-June 2019. The population in this study was all students of Grade XI MIPA in MAN in Bogor City in the academic year 2018/2019 with a total sample of 207 respondents. Research data were obtained using multiple choice test and observation sheet. Quantitative data analysis with descriptive statistical calculations, prerequisite tests using the Lilliefors test and the Bartlett test. The data hypotheses testing used the Pearson Product Moment formula. Analysis of qualitative data carried out by reducing data, presenting data, and drawing conclusions. The results showed that there was a positive relationship between knowledge of disaster mitigation and disaster preparedness behaviors (t -value 3.56 > t -statistic 0.05, $r=0.234$ & $r^2=5.51\%$) with a low interpretation value. The conclusion of this research there were low relationship between knowledge of disaster and preparedness behaviors.
	Keywords: Disaster mitigation; disaster preparedness behavior; students
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INTRODUCTION

Indonesia is one of natural disaster-prone countries as geographically it is an archipelago located between two of the world's great oceans, namely: Indian Ocean and Pacific Ocean. Indonesia's geological position is located at the confluence of three large tectonic plates, namely: Indo-Australian, Eurasian, and Pacific and a series of rings of fire that extend along the Pacific plate, which is the most active tectonic plate in the world. Consequently, earthquake is often occurred and creates tidal wave if it happens in the ocean. Disaster vulnerability condition should be counterbalanced with efforts to increase disaster preparedness (Cianfrani et al., 2018; Kelman et al., 2016). Indonesia's condition that is vulnerable to disaster should be balanced with efforts to enhance disaster preparedness as high vulnerability without preparedness as a part of capacity will increase disaster risks. Preparedness is a prepare condition due to a series of activities carried out to anticipate possibilities of disaster in preventing victims through organizing and appropriate measures (Rahmayanti et al., 2020). One of important to prevent disaster is Disaster preparedness.

Disaster preparedness is all individual's interest because disaster could happen to anyone, at anytime and anywhere (Dahl & Millora, 2016; Dewi & Dartanto, 2019). The role of education affects the achievement of disaster preparedness. In disaster mitigation education, individual preparedness will be improved in learning. The individual preparedness to disaster can be indicated from knowledge, skills, and abilities acquired through learning and from experiences applied during an emergency condition (Rahmayanti et al., 2020). Referring to development perspective, adolescence has a high potential to achieve a rapid development in thinking skills and a shift to a new role in the society (Gersons et al., 2020; Xu & Lu, 2018). Children are the most vulnerable age to risk of becoming a victim of a disaster; therefore, disaster mitigation education for students is one of measures to reduce the disaster risks. Students' disaster preparedness is a necessity to reduce risks of disasters that could happen at any time.

Disaster preparedness behaviors are required because it is part of the capacity to minimize disaster risks. Disaster risks can be measured by multiplying hazard/H by vulnerability/V and divided it by capacity/C (Amri et al., 2016). Threats or hazards become a disaster if a community is vulnerable or has lower capacity than the hazard level, or they even become a source of the disaster (Escobar et al., 2020; Ramirez-Andreatta et al., 2016). Hence, improving disaster preparedness behaviors as a part of the capacity will reduce the disaster risks. Disaster could occur at any time or unpredictable and it could happen to anyone. This is one of factors for the importance of disaster preparedness behaviors.

Components influencing human behavior include cognitive, affective, and conative. The cognitive component is an intellectual aspect related to what man knows. The affective component is an emotional aspect. Conative component is a volitional aspect related to habits and willingness to act (Olsson et al., 2020). Behaviors that are based on knowledge and awareness of positive attitude will be lasting. On the contrary, the behaviors will not last long if it is not based on knowledge and awareness (Chouhan et al., 2017; Shabani et al., 2013). Human behaviors are actually the reflection of various psychiatric symptoms, such as knowledge, passion, desire, interest, motivation, perception, and attitudes (Mao, 2014; Truelove & Gillis, 2018). The disaster preparedness behaviors are activities or actions to prepare that are conducted to anticipate possibilities of a series of events occurred suddenly or gradually that threaten and disturb people's live and livelihood, to prevent victims through organizing and appropriate measures.

Knowledge is a set of information acquired from experience or from birth that makes a person knows something (Glynn et al., 2007). Knowledge of disaster mitigation is a set of information derived

from the results of human sensing that consists of four categories, namely: factual knowledge, conceptual, procedural, and metacognitive of a series of efforts to reduce disaster risks before the disaster occurs through structural and non-structural approaches. Especially this knowledge information received in Biology education in schools. Knowledge of disaster mitigation needs to be possessed by the whole community, especially in these case students at the school level. This is because students contribute or have a role to play in overcoming environmental problems. The problem that arises is that students' low knowledge of disaster mitigation is still low (Rahmayanti et al., 2020; Suharini, et al., 2020).

Based on the aforementioned, knowledge is one of components that influence behaviors. The low students' disaster preparedness behaviors are assumed to be related to the lack of learning on disaster mitigation. Disaster mitigation learning at senior high school level could be found in geography subject. Due to selection of majors of natural sciences or social sciences that starts from Grade X, students in the natural sciences major receive less learning about disaster, which is only in the Biology subject. The problem that arises is the students' low knowledge of natural disasters. Meanwhile, there are many disasters that must be anticipated in everyday life. This resulted in many students not being able to cope with the disaster. Knowledge concept on disaster mitigation is crucial; therefore, it should be more detail to add students' insight. In turn, it will be expected to be realized in the form of students' disaster preparedness behaviors thus improving the capacity that could reduce disaster risks. The disaster mitigation learning affects knowledge of disaster mitigation and it is assumed to have impact on students' disaster preparedness behaviors (Rahmayanti et al., 2020; Suharini et al., 2020). This will significantly influence the magnitude of risks to be borne if a disaster occurs. The research aims to identify relationship between knowledge of disaster mitigation and disaster preparedness behavior and other factors that have a relationship with disaster preparedness behaviors in Biology learning in the classroom.

RESEARCH METHODS

Method in the research was quantitative with correlational study. The research carried out at MAN (Islamic Senior High School) in Bogor City in semester II of the academic year 2018-2019. The research started from January to June 2019. There were two variables in the research, namely: independent variable (X) was knowledge of disaster mitigation and dependent variable (Y) was disaster preparedness behaviors. The research connected one independent variable to one dependent variable. The research design is formulated in the following figure.

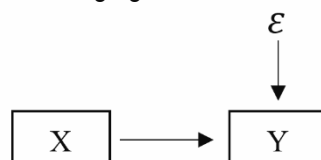


Figure 1 Relationship between Variables

Where:

X = Knowledge of disaster mitigation (Independent variable)

Y = Disaster preparedness behaviors (Dependent variable)

ε = Other factors influencing the variable Y

Population in the research included all students of Grade XI MIPA in MAN in Bogor City in the academic year 2018-2019 with number of samples was 207 respondents. Sampling carried out using Slovin's criteria with proportional random. Instrument used in this research was instrument about knowledge of disaster mitigation with test and preparedness behavior with questionnaire. Instruments given to students. Data of quantitative research were derived using 32 multiple-choice questions with 4 answer choices for variable X and 33 questionnaire items for variable Y. Instrument calibration test had been conducted previously on 40 items of initial question and questionnaire items. The instrument validity test used a point-biserial and Pearson's product-moment. The instrument reliability test utilized Kuder Richardson (KR) 20 and Cronbach's Alpha. The instrument has been declared valid and reliable. The quantitative data analysis employed descriptive statistic calculation. Prerequisite tests consisted of normality test using Lilliefors test with criteria: if $L_o < L_t$, then estimated standard error ($Y - \hat{Y}$) is originated from a normally distributed population and homogeneity test used Bartlett test with criteria: if χ^2 value $<$ χ^2 statistic then the sample comes from a homogenous population. The data hypothesis testing used correlation test with Pearson's product moment formula to identify the magnitude of the relationship between knowledge of disaster mitigation and disaster preparedness behaviors and correlation significance test carried out by using t-test by Statistical Package for the Social Sciences (SPSS).

FINDINGS AND DISCUSSION

The research result data were generated using two research types, namely: quantitative and qualitative. The quantitative data included description of the research result data, analysis prerequisite tests of normality and homogeneity tests, and hypothesis testing. The qualitative data consisted of data reduction, data presentation, and conclusion drawing. The description of the research result data embodied dependent variable data of disaster preparedness behaviors (Y) and independent variable of knowledge of disaster mitigation (X). The number of data was 207 respondents from Grade XI MIPA in MAN in Bogor City.

The disaster-preparedness behavior variable was measured using questionnaire with rating scale. The number of samples was 207 respondents. The research results obtained the highest score of 141 and the lowest score was 68 with score range of 73. The score mean was 96.87, whereas median was 95 and modus was 92. Based on the calculation, the result of variance value was 218.37 with standard deviation (SD) of 14.77. The total score was 20053 with class interval of 9.

Variable of knowledge of disaster mitigation was measured using multiple-choice questions with four answer choices. The research results obtained the highest score of 29 and the lowest score was 6 with score range of 23. The score mean was 19.005, whereas median was 19 and modus was 19. Based on the calculation, the result of variance value was 24.44 with standard deviation (SD) of 4.94. The total score was 3934 with class interval of 3.

The hypotheses were tested using parametric statistic method of correlation test and regression test. The tested data consisted of knowledge of disaster mitigation (X) and disaster preparedness behaviors (Y). The hypothesis testing aimed at identifying whether the hypothesis proposed is accepted or rejected at a confidence level $\alpha = 0.05$. The regression linearity testing is intended to find out whether the regression model Y on X utilized is linear or vice versa. The calculation result indicated that F value was 1.26 smaller than F statistic of 1.61 with significance level $\alpha = 0.05$. The result can be interpreted that the regression model Y on X was linear. The regression significance testing result indicated F value of 11.957, which was greater than F statistic of 3.89 with significance level $\alpha = 0.05$. This suggested that the regression $Y = 83.54 + 0.70x$ was significant.

The correlation calculation results suggested that the correlation coefficient was positive with $r = 0.23$ and coefficient of determination of 5.51%. The significance of the correlation value calculation obtained $t\text{-value} = 3.56$ and t statistic for significance level $\alpha = 0.05$ of 1.97. Hence, $t\text{-value} > t\text{-statistic}$ or the correlation was significant. This suggested that there was a low positive relationship between knowledge of disaster mitigation (X) and disaster preparedness behaviors (Y). The low relationship was indicated by the value of correlation coefficient (r) that less than 0.4.

The other data analysis for supported this research carried out once data from the quantitative research are generated. Based on the quantitative research results, the correlation coefficient value between knowledge of disaster mitigation and disaster preparedness behaviors was 0.23. The correlation coefficient suggested a low relationship as it was less than 0.4. Consequently, the research sub-focus would be to explore the cause of the low relationship between knowledge of disaster mitigation and disaster preparedness behaviors and factors deemed to have relationship with disaster preparedness behaviors. Following section discusses the result of qualitative research based on data and information from each research sub-focus.

Sub-focus 1: "Please explain why the correlation between disaster mitigation and disaster preparedness behavior is low? Conclusion of sub-focus 1: Factors causing the low correlation between knowledge of disaster mitigation and disaster preparedness behavior were that students received limited learning of the disaster mitigation in school and the disaster mitigation knowledge acquired by the students was merely a possession or knowledge without application in the form of disaster preparedness behaviors. This was due to their lack of awareness to the environment and disasters that might occur; therefore, the students had no desire to behave in disaster preparedness (Dewi & Dartanto, 2019; Ramadhan et al., 2019). Social environment could also a factor, as students were rare to discuss about disaster preparedness because they considered the topic uninteresting thus it influenced their behaviors. Disasters that are rarely occurred in the natural environment could also affect the students' disaster preparedness behaviors. Sub Focus 2: "Are there other factors that have relationship with disaster preparedness behavior besides knowledge of disaster mitigation?" Conclusion of Sub Focus 2: Other factors that had relationship with disaster preparedness behavior included students' self-awareness of the importance of disaster preparedness, students' consciousness of the environment and disasters that might occur. Students have to prevent disaster and learning about disaster in school (Suharini et al., 2020).

The data analysis and hypothesis testing results suggested that there was a positive relationship between knowledge of disaster mitigation and disaster preparedness behavior of students in Grade XI Senior high school in Bogor city. This suggests that the research hypothesis is accepted thus knowledge of disaster mitigation have contribution in fostering disaster preparedness behaviors. The qualitative research results in the first sub-focus reveal that there are several factors causing the low correlation between knowledge of disaster mitigation and disaster preparedness behaviors, namely internal and external factors. The internal factors include the students were merely acquired or knew about knowledge of disaster mitigation without application in the form of disaster preparedness behaviors, lack of the students' awareness or consciousness to the environment and disasters that might occur, and the students had no desire to behave in disaster preparedness.

Those internal factors are closely related to the external factors that behavior is a totality of someone's appreciation and activity, which is the joint result of internal and external factors (Tsai et al., 2015; Vincent-Ruz & Schunn, 2017). This is indicated by the lack of the students' awareness to their surrounding environment and disasters due to the limited learning about disaster mitigation in schools.

The non-existence of specific subject on disaster-based environmental education in formal education has contributed to the lack of awareness among young generation to their surrounding environment maintenance and perseverance (Purwanto et al., 2020; Rahmayanti et al., 2020). Therefore, a disaster-based environmental education in childhood is necessary to reduce disaster risks. Students find it difficult to understand various environmental disaster concepts in more detail. This has resulted in the students' low understanding of natural disasters in more depth. The concepts taught in school are sometimes only basic and general. In addition, students should also be given a guide in the form of project-based learning to improve their abilities (Jewpanich & Piriyasurawong, 2015; Lou et al., 2017).

Learning in schools about disaster mitigation is still limited for Biology education. Only several students receive geography subject through cross interest. Moreover, the subject is also limited in biology learning based on Basic Competence on data analysis of environmental changes, the causes, and impacts on life. This will affect disaster preparedness behavior that the low preparedness index value at the school community level has an implication on the importance of the roles and responsibilities of the government, societies, and school communities in various facilities (Dumitrica, 2017; Hessenauer & Law, 2017; Rahmayanti et al., 2020). The facilities can be in the form of support of policies for the schools on the importance of disaster education curriculum to be applied in a subject. This is inseparable from the role of the school communities as the main stakeholder in improving disaster preparedness. Through the school communities, knowledge of and awareness about disaster can be provided since early age.

Another external factor is social environment that has a significant influence, as the students are rare to discuss about disaster mitigation. This is because they deemed the topic as uninteresting; therefore, this will influence the students' behaviors and their caring attitude. Discussion about disaster mitigation will improve student knowledge and caring attitude towards disasters. Behavior is determined by or depended on the environment or stimulus with the related organism (Avan et al., 2011; Goldman et al., 2017). Social environment affects individual decision and in turn, it will influence behavior. That social environment factors, especially people who have influence on an individual life, could affect the individual decision (Cheung et al., 2015; Costa et al., 2018). Therefore, social environment could shape the students' disaster preparedness behaviors, especially in biology education.

The last external factor is natural environment factor or the vulnerability level of the surrounding environment. This factor could influence the correlation because it is connected to the students' experiences. Students who have disaster experiences will have a higher alert attitude and attitude is one factor that affects behavior as previously discussed. Experience also affects behavior as that knowledge, skills, experiences, believes, time availability, and the availability of facilities to perform the behaviors are several factors that influence behavior (Goldman et al., 2014, 2015). Chung & Yen (2016) suggested that school education should focus to develop disaster prevention literacy among students. It consists of three dimensions: (a) disaster prevention knowledge: disaster knowledge, preparedness knowledge, and response knowledge, (b) disaster prevention attitude: prevention awareness, prevention values, and prevention sense of responsibility, and (c) Disaster prevention skills: preparedness action and response behaviors.

The qualitative research results in the second sub-focus indicate other factors that have a relationship with disaster preparedness behavior besides the knowledge of disaster mitigation. The factor includes students' self-awareness on the importance of disaster preparedness. This is consistent with Rahmayanti et al. (2020) that lack of understanding and awareness of communities on the disaster risks in their areas inflicts the lack of vigilance and preparedness in facing disasters. Another factor is

students' consciousness on the preparedness, students' desire to be alert, and students' habits in disaster preparedness behaviors. Students' habit is assumed to be influenced by family environment because it is affected by efforts to shape their habit from early age by the family to behave in disaster preparedness. The student habit from their early age affects behavior because one of ways to shape behavior is through habituation.

Children are the most vulnerable group to be victims of disasters; therefore, by providing learning on disaster mitigation since early age to the children could improve their knowledge and alert behavior to minimize the number of victims. Learning on disaster mitigation also crucial for teenager that based on the development perspective, adolescence has a high potential to achieve rapid development in thinking skills and a shift to a new role in the society (Ramadhan et al., 2019; Tsai et al., 2015). Therefore, it is expected that teenagers provided with learning on disaster mitigation in Biology education will be capable of providing suitable intervene during disaster, such as helping others and educate others on preparedness as well as active in disaster prepared community. This will be an additional reference to include disaster mitigation education in the education curriculum in the form of subject learned in all majors. Biology education in schools is one of ways to implement it in a formal path, whereas biology education can also be carried out in non-formal path.

CONCLUSION

Based on the research results it can be concluded that there was a positive relationship between knowledge of disaster mitigation and disaster preparedness behaviors. The positive relationship was indicated by regression equation $\hat{Y} = 83.54 + 0.70x$ with $r = 0.23$ and $r^2 = 5.51\%$. Further research that needs to be done is related to the development of various teaching materials or learning media to be able to increase capacity in disaster mitigation. In addition, it is also related to the ability to be able to apply flood behavior in everyday life through learning biology.

REFERENCES

- Amri, M. R., Yulianti, G., Yunus, R., Wiguna, S., Adi, A. W., Ichwana, A. N., & Septian, R. T. (2016). Risiko bencana Indonesia. Badan Nasional Penanggulangan Bencana. Retrieved from <https://bnpb.go.id/kajian-bencana/risiko-bencana-indonesia>
- Avan, C., Aydinli, B., Bakar, F., & Alboga, Y. (2011). Preparing attitude scale to define students' attitudes about environment, recycling, plastic and plastic waste. *International Electronic Journal of Environmental Education*, 1(3), 179–191. Retrieved from <https://dergipark.org.tr/en/pub/ijeegreen/issue/7905/104039>
- Cheung, L. T. O., Fok, L., Tsang, E. P. K., Fang, W., & Tsang, H. Y. (2015). Understanding residents' environmental knowledge in a Metropolitan City of Hong Kong, China. *Environmental Education Research*, 21(4), 507–524. <https://doi.org/10.1080/13504622.2014.898247>
- Chouhan, S., Bhatnagar, B., Suman, & Kaur, M. (2017). Assessment of environmental attitude of adolescent of Bikaner City. *Studies on Home and Community Science*, 11(1), 25–28. <https://doi.org/10.1080/09737189.2017.1336308>
- Chung, S., & Yen, C. (2016). Disaster prevention literacy among school administrators and teachers: a study on the plan for disaster prevention and campus network deployment and experiment in Taiwan. *Journal of Life Sciences*, 10, 203–214. Retrieved from https://digitalcommons.odu.edu/efl_fac_pubs/7/
- Cianfrani, C., Broennimann, O., Loy, A., & Guisan, A. (2018). More than range exposure: global otter vulnerability to climate change. *Biological Conservation*, 221(February), 103–113. <https://doi.org/10.1016/j.biocon.2018.02.031>

- Costa, E., Montemurro, D., & Giuliani, D. (2018). Consumers' willingness to pay for green cars: A discrete choice analysis in Italy. *Environment, Development and Sustainability*, 1–18. <https://doi.org/10.1007/s10668-018-0141-z>
- Dahl, K. K. B., & Millora, C. M. (2016). Lifelong learning from natural disasters: Transformative group-based learning at Philippine Universities. *International Journal of Lifelong Education*, 35(6), 648–663. <https://doi.org/10.1080/02601370.2016.1209587>
- Dewi, L. P. R. K., & Dartanto, T. (2019). Natural disasters and girls vulnerability: Is child marriage a coping strategy of economic shocks in Indonesia?. *Vulnerable Children and Youth Studies*, 14(1), 24–35. <https://doi.org/10.1080/17450128.2018.1546025>
- Dumitrica, D. (2017). Fixing higher education through technology: Canadian media coverage of massive open online courses. *Learning, Media and Technology*, 42(4), 454–467. <https://doi.org/10.1080/17439884.2017.1278021>
- Escobar, R. S., Diaz, L. O., Guerrero, A. M., Galindo, M. P., Mas, E., Koshimura, S., Adriano, B., Urra, L., & Quintero, P. (2020). Tsunami hazard assessment for the Central and Southern Pacific Coast of Colombia. *Coastal Engineering Journal*, 62(4), 1–13. <https://doi.org/10.1080/21664250.2020.1818362>
- Gersons, B. P. R., Smid, G. E., Smit, A. S., Kazlauskas, E., & McFarlane, A. (2020). Can a 'second disaster' during and after the COVID-19 pandemic be mitigated?. *European Journal of Psychotraumatology*, 11(1), 1815283. <https://doi.org/10.1080/20008198.2020.1815283>
- Glynn, S., Taasobshirazi, G., & Fowler, S. (2007). Analogies: Explanatory tools in web-based science instruction. *Educational Technology*, 47(5), 45–50. Retrieved from <https://www.jstor.org/stable/44429443?seq=1>
- Goldman, D., Ayalon, O., Baum, D., & Haham, S. (2015). Major matters: Relationship between academic major and university students' environmental literacy and citizenship as reflected in their voting decisions and environmental activism. *International Journal of Environmental and Science Education*, 10(5), 671–693. <https://doi.org/10.12973/ijese.2015.260a>
- Goldman, D., Pe'er, S., & Yavetz, B. (2017). Environmental literacy of youth movement members—is environmentalism a component of their social activism?. *Environmental Education Research*, 23(4), 486–514. <https://doi.org/10.1080/13504622.2015.1108390>
- Goldman, D., Yavetz, B., & Pe'er, S. (2014). Student teachers' attainment of environmental literacy in relation to their disciplinary major during undergraduate studies. *International Journal of Environmental and Science Education*, 9(4), 369–383. <https://doi.org/10.12973/ijese.2014.222a>
- Hessenauer, S. L., & Law, K. (2017). Mentoring: A Natural Role for Learning Community Faculty. *Learning Communities: Research & Practice*, 5(2). Retrieved from <https://core.ac.uk/display/267853497>
- Jewpanich, C., & Piriyasurawong, P. (2015). Project-based learning using discussion and lesson-learned methods via social media model for enhancing problem solving skills. *International Education Studies*, 8(6), 24–31. <https://doi.org/10.5539/ies.v8n6p24>
- Kelman, I., Gaillard, J. C., Lewis, J., & Mercer, J. (2016). Learning from the history of disaster vulnerability and resilience research and practice for climate change. *Natural Hazards*, 82, 129–143. <https://doi.org/10.1007/s11069-016-2294-0>
- Lou, S. J., Chou, Y. C., Shih, R. C., & Chung, C. C. (2017). A study of creativity in CaC2 steamship-derived STEM project-based learning. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(6), 2387–2404. <https://doi.org/10.12973/eurasia.2017.01231a>
- Mao, J. (2014). Social media for learning: A mixed methods study on high school students' technology affordances and perspectives. *Computers in Human Behavior*, 33(1), 213–223. <https://doi.org/10.1016/j.chb.2014.01.002>
- Olsson, D., Gericke, N., Sass, W., & Pauw, J. B. (2020). Self-perceived action competence for sustainability: The theoretical grounding and empirical validation of a novel research instrument. *Environmental Education Research*, 26(5), 742–760. <https://doi.org/10.1080/13504622.2020.1818362>

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- Purwanto, A., Ichsan, I. Z., Gomes, P. W. P., Rahman, M. M., & Irwandani, I. (2020). ESBOR during COVID-19: Analysis students attitude for develop 21st century environmental learning. *Journal of Sustainability Science and Management*, 15(7), 20–29. <https://doi.org/10.46754/jssm.2020.10.003>
- Rahmayanti, H., Ichsan, I. Z., Azwar, S. A., Purwandari, D. A., Pertiwi, N., Singh, C. K. S., & Gomes, P. W. P. (2020). DIFMOL: Indonesian students' HOTS and environmental education model during COVID-19. *Journal of Sustainability Science and Management*, 15(7), 10–19. <https://doi.org/10.46754/jssm.2020.10.002>
- Ramadhan, S., Sukma, E., & Indriyani, V. (2019). Environmental education and disaster mitigation through language learning. *IOP Conf. Series: Earth and Environmental Science*, 314. <https://doi.org/10.1088/1755-1315/314/1/012054>
- Ramirez-Andreotta, M. D., Lothrop, N., Wilkinson, S. T., Root, R. A., Artiola, J. F., Klimecki, W., & Loh, M. (2016). Analyzing patterns of community interest at a legacy mining waste site to assess and inform environmental health literacy efforts. *Journal of Environmental Studies and Sciences*, 6(3), 543–555. <https://doi.org/10.1007/s13412-015-0297-x>
- Shabani, N., Ashoori, M., Taghinejad, M., & Beyrami, H. (2013). The study of green consumers ' characteristics and available green sectors in the market. *International Research Journal of Applied and Basic Sciences*, 4(7), 1880–1883. Retrieved from <https://irjabs.com/en/archive.php?rid=41>
- Suharini, E., Ariyadi, M. H., & Kurniawan, E. (2020). Google Earth Pro as A Learning Media for Mitigation and Adaptation of Landslide Disaster. *International Journal of Information and Education Technology*, 10(11), 820–825. Retrieved from <http://www.ijiet.org/show-146-1705-1.html>
- Suharini, E., Kurniawan, E., & Ichsan, I. Z. (2020). Disaster mitigation education in the COVID-19 pandemic: A case study in Indonesia. *Sustainability (United States)*, 13(6), 292–298. <https://doi.org/10.1089/sus.2020.0053>
- Truelove, H. B., & Gillis, A. J. (2018). Perception of pro-environmental behavior. *Global Environmental Change*, 49(February), 175–185. <https://doi.org/10.1016/j.gloenvcha.2018.02.009>
- Tsai, M. H., Wen, M. C., Chang, Y. L., & Kang, S. C. (2015). Game-based education for disaster prevention. *AI and Society*, 30(4), 463–475. <https://doi.org/10.1007/s00146-014-0562-7>
- Vincent-Ruz, P., & Schunn, C. D. (2017). The Increasingly important role of science competency beliefs for science learning in girls. *Journal of Research in Science Teaching*, 54(6), 790–822. <https://doi.org/10.1002/tea.21387>
- Xu, J., & Lu, Y. (2018). Towards an earthquake-resilient world: from post-disaster reconstruction to pre-disaster prevention. *Environmental Hazards*, 17(4), 269–275. <https://doi.org/10.1080/17477891.2018.1500878>