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The Education of Tidal Flood Disaster Mitigation and Environmental Awareness Through Simulation Video Assisted-Problem Based Learning Model

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Abstract: The purpose of this research is to determine the tidal flood disasters mitigation understanding and environmental awareness, as well as to measure the achievement of learning outcomes through the implementation of simulation video assisted problem-based learning. This research used pre-experimental design with one-group pretest-posttest, with the sample is seventh-grade students at Barunawati Junior High School Semarang. The instruments used are multiple-choice questions and Likert scale questionnaire. Rasch model was used to measure the instrument validity and to investigate the attitude scale of environmental awareness due to the learning model implementation, while N-gain test and t-test was used for cognitive analysis of climate change and tidal flood disaster mitigation materials. The knowledge of climate change and tidal flood disaster mitigation increased with N-gain of 0.40 and 0.37, respectively, while the results of t-test for learning outcomes in climate change and tidal flood disaster mitigation showed a significant increase in cognitive learning outcomes, since the video simulation-learning encouraged students to be more active and responsive. Furthermore, the analysis of the attitude scale questionnaire showed an improvement with person measure value from 0.04 (pretest) to 0.84 (posttest). It can be concluded the simulation video assisted problem-based learning model can increase climate change and tidal flood disaster mitigation knowledge, and environmental awareness of students.

Keywords: Climate change; Environmental awareness; Problem-based learning model; Simulation video; Tidal flood mitigation

Introduction

Indonesia is a country prone to disasters. According to data from BNPB as of September 2021, there were 1969 disaster events from January to September 2021, consisting of floods, extreme weather, landslides, forest and land fires, and droughts (B.N.P.B., 2021). Particularly, according to Syafei et al. (2017), the topography of the northern region of Semarang is flat, making it very easy for tidal flooding to enter the mainland. On the other hand, the northern region of Semarang is a coastal area and a center of community activities. Then, Ikhwanudin et al. (2020) stated that coastal flooding is caused by global warming, which raises the Earth's temperature and causes the sea level to rise, influenced by tides.

The understanding and skills of the people in disaster management processes are important to minimize disaster risks and their impacts (Suarmika et al., 2017). This is in line with Qodrifuddin et al. (2022), which reveals that the problem that currently exists in society is the lack of understanding of disasters and their mitigation. Conversely, the society considers issues related to disasters easy, resulting in apathy towards the environment and surrounding nature.

Disaster mitigation is a step that must be taken by the community, especially in the field of education. This is in line with the opinion of Wahyono et al. (2022), as

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increasing number of natural disasters, there is a need for the implementation of disaster risk reduction in education. According to Agusty et al. (2021), disaster mitigation can be taught by integrating the science learning process closely related to disasters. Even to complete students' understanding of the concept of natural disasters and their mitigation in real conditions, simulation activities are needed (Atmojo et al., 2018). Further, Rusilowati et al. (2020) found that disaster education using simulations can be carried out by integrating disaster material with science lessons. Furthermore, problem-based learning model can stimulate students to solve real-world phenomena problems (Ali et al., 2019).

According to Nickl et al. (2022), video is a very flexible and easy-to-use medium. In the learning process, video is very much needed because it can attract students' interest in learning, and learning videos also make it very easy for students to learn in the classroom or independently. Lastly, when the material presented in the video also facilitates students to learn independently without asking the teacher repeatedly.

This research aims to improve students' understanding of science subjects, particularly climate change and tidal flood mitigation, and to obtain and analyze the difference in students' disaster awareness before and after learning with the video-assisted problem-based learning simulation model.

Method

This research was conducted at SMP Barunawati in Semarang City, Indonesia with a population of all seventh-grade students. The research sample was taken using random sampling technique, and the type of research was pre-experimental design with one group pretest-posttest design as shown in Table 1.

Table 1. Design of One Group Pretest-Posttest Research

Pretest	Treatment	Posttest
O_1	X	O_2

Data collection was carried out through tests and attitude scale questionnaires. The test instrument was designed based on three indicators, namely: understanding of the dangers and risks of disasters and climate change, ability to identify signs and symptoms of disasters and climate change, and level of ability and skills in disaster situations caused (Barclay et al., 2008; Roy et al., 2022; Tint et al., 2015). Meanwhile, the attitude scale questionnaire was developed based on indicators of caring, curiosity, criticality, steadfastness, and responsibility (Fischer et al., 2015).

Data collection through tests was carried out in the form of pretest and posttest on the material of flood and climate change disaster mitigation using a test instrument that has been validated by 2 experts. Similarly, the attitude scale questionnaire was conducted using attitude instruments arranged in the form of Likert scale, which has also been validated by 2 experts, in the form of an attitude questionnaire on environmental awareness before and after the learning treatment. The treatment carried out was learning using the problem-based learning model assisted by simulation video.

Instrument analysis was carried out using the Rasch model. According to Medriati et al. (2022), Rasch model has many benefits, including the ability to evaluate whether the item is fit and analyze whether the item is biased. The initial data (pretest) analysis stage is a normality test to investigate the normality of student data, N-gain test analysis to determine the difference in knowledge of the climate change and flood disaster mitigation materials, and the last is a different test analysis (t-test) to analyze the comparison of cognitive learning outcomes of climate change and flood disaster mitigation materials. This is in line with research conducted by Verawati et al. (2021), who found that after learning using reflective inquiry learning model, there was moderate score increase for the students. Finally, the environmental awareness attitude scale was analyzed by Rasch model with item person measure to determine the difference in student attitudes before and after the treatment.

Result and Discussion

Observation and data collection results were used to determine the improvement of cognitive learning outcomes in the form of knowledge on the material of climate change and tidal flood disaster mitigation, as well as environmental awareness attitudes, which is in line with Jalaluddin et al. (2022) that found an increase of disaster awareness of students treated by simulation-integrated with science subject. As an initial stage, the analysis of teaching materials, videos, and instruments used (including the analysis of instrument validity of both climate change and tidal flood disaster mitigation test, and attitude scale of environmental awareness) was carried out using the Rasch model. The Rasch model was chosen because of its simplicity and effectiveness in instrument development analysis, among others, it is able to produce more objective and accurate analysis and can be used on small sample sizes so that the resulting instrument is more valid and reliable (Khalaf et al., 2022; Kim, 2021; Zhou et al., 2019). Then, using the Rasch model, students with high ability should have a higher probability of answering a question correctly than that other. Conversely, students with lower ability have a smaller chance of correctly answering a question with a higher difficulty level (Sumintono et al., 2015). The results of the validation analysis of teaching materials, learning videos, test and questionnaire instruments are shown in Table 2.

Table 2. Expert Validation Analysis of Teaching Materials, Learning Videos, and Test and Questionnaire Instruments

Category	The value for		
	1*)	2**)	3***)
Outfit MNSQ	1.00	1.00	1.00
Outfit ZSTD	-1.10	-1.00	-1.10
Pt Measure Corr	0.56	0.71	0.67
Item Measure	0.15	-0.23	-0.02

*) Teaching materials and learning videos, **) Climate change and tidal flood disaster mitigation instruments, ***) Environmental care attitude scale questionnaire.

Table 2 shows that the teaching materials on climate change and tidal flood disaster mitigation and the climate change video are suitable for use in learning, indicated by the Outfit MNSQ and Outfit ZSTD values in the range of 0.50 to 1.50 and between -2.00 to 2.00 respectively. The teaching materials and video used for simulation also have a level of ease of application, indicated by the item measure values between 0.00 - 1.00. They also have a fairly good ability to distinguish students with high, medium, and low abilities, indicated by the point measure correlation values between 0.40 to 0.85 (Sumintono et al., 2015).

The same trend was also obtained in the validation of the climate change and tidal flood mitigation test instrument, with instrument compatibility with the model, indicated by the Outfit MNSQ and Outfit ZSTD values of 1.00 and -1.00, respectively, with a very good ability to differentiate student level (point measure correlation value of 0.71). The level of difficulty of climate change and tidal flood mitigation questions can be said to be moderate and tend towards easy, indicated by the item measure values below 0.00 (Sumintono et al., 2015; Zhou et al., 2019). Finally, the environmental awareness attitude questionnaire was found to have instrument compatibility with the model, according to the respective Outfit MNSQ and Outfit ZSTD values of 1.00 and -1.10 respectively. The ability of the questionnaire to distinguish the attitudes of respondents is also very good (point measure correlation value of 0.67), with a very easy level of difficulty for respondents to fill out, indicated by item measure that below 0.00 (Khalaf et al., 2022; Sumintono et al., 2015).

An analysis of learning outcomes improvement was carried out using a normality test using the Shapiro-Wilk test on pretest and posttest data on climate change and tidal flood mitigation using IBM SPSS Statistic 21 software (Agustoni et al., 2021), and the results are presented in Table 3. Based on normality test, it was found that the data fell into the normal category. The analysis of the achievement of cognitive learning outcomes in the science of climate change and tidal flood mitigation has been done to obtain results as in Table 4.

Table 3. Normality Test Results of Students on Climate Change and Flood Mitigation Materials

Material	Test	Normality Test Result	
		Sig	Criteria
Climate change	Pretest	0.608	Normal
	Posttest	0.535	Normal
Tidal flood mitigation	Pretest	0.243	Normal
	Posttest	0.104	Normal

The N-gain test was conducted to determine the extent of cognitive learning improvement, and according to Table 3, the relative increase in student understanding of climate change and tidal flood disaster mitigation is considered moderate. This result is consistent with a research result that implementation of the creative problem-solving learning model, the N-gain index was 0.46, which is also classified as moderate (Rahayu et al., 2022). The similar result was found in a study by Fai (2018), who found an increase in scores between before and after treatment.

Table 4. Achievement of Cognitive Learning Outcomes on Climate Change and Flood Mitigation Materials

Category	Climate change score		Flood mitigation score	
	Pretest	Posttest	Pretest	Posttest
Highest score	64.29	92.86	64.29	92.86
Lowest score	7.14	35.71	7.14	35.71
Average score	36.79	64.29	35.36	60.50
N-gain (%)		43.50		38.90

To test the significance of the learning improvement, a one-sample t-test was used (Tanjung et al., 2022). With df = 19 and $\alpha = 5\%$, it was found that the t-calculated value was greater than the t-table value, meaning that the simulation video assisted-problem-based learning significantly improved student learning outcomes, both in terms of climate change and tidal flood disaster mitigation (Table 5). This improvement occurs since the video provide a visual and interactive experience that allows learners to engage with complex concepts in a more accessible way. Additionally, video simulations can also be used to create scenarios that allow learners to experience the impacts of climate change and tidal floods first-hand, which can help to foster a sense of urgency and motivate an action (Tolppanen et al., 2022).

Table 5. Results of the Comparison Test of the Increase in Understanding of Climate Change and Flood Mitigation

Material	t-calc	t-table
Climate change	18.912	1.729
Flood mitigation	15.312	1.729

Based on Figure 1, there was an improvement in each indicator of understanding and awareness of tidal flood and climate change mitigation from pre-test to post-test. The indicator related to the level of understanding of disaster and climate change risks increased with N-gain of 63%. This increase in understanding and awareness can be attributed to problem-based learning using video simulations, which can provide a learning experience that is closer to real disaster situations and allows students to actively engage in solving related problems (Khanal et al., 2022; Simsek et al., 2021; Wahyuni et al., 2019).

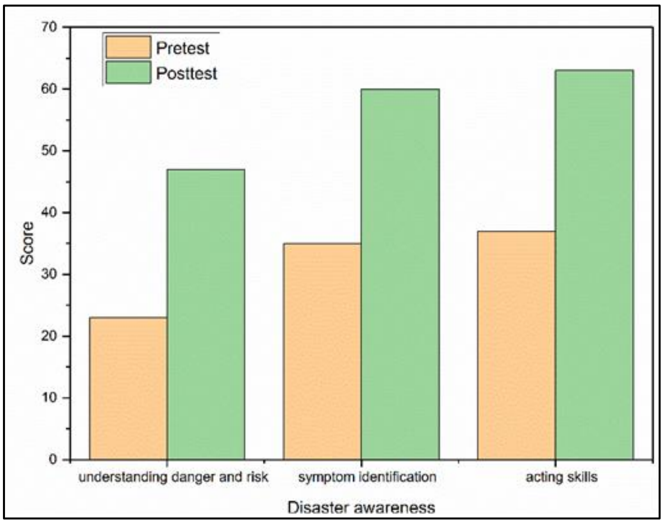

Figure 1. Understanding of climate change and tidal flood mitigation for every indicator

Looking at each indicator in detail, there was an improvement in all of them. In terms of the ability to identify signs and symptoms of disasters and climate change (N-gain = 37%), this may be due to the fact that the applied learning model can make students feel as if they were experiencing the disaster situation themselves, along with its impact on the environment and society, thus providing direct experience for students to make decisions and take actions in emergency situations (Rajabi et al., 2022; Yamori et al., 2018).

Regarding the indicators related to the ability and skills in disaster situations, a relatively moderate improvement was observed with an N-gain of 63%. This improvement may be attributed to video simulation-assisted problem-based learning, which can guide students to understand and apply the learned actions in situations that are relevant to real life and encourage students to learn social skills, as well as hone their ability to work in teams and make appropriate decisions in complex and difficult situations when a disaster occurs (Sheehy et al., 2022).

Table 6. Achievement of Environmental Attitudes

Category	The value for	
	Pretest	Posttest
Person measure	0.06	0.84

Table 6 shows the results of the analysis of environmental awareness attitude scale using the Rasch model. As Rusilowati (2018) said that person measure in Rasch model is a representation that indicates the level of individual ability. Based on the person measure value, there was a significant improvement in students' environmental awareness attitudes. The increase in students' ability in environmental awareness and attitude can be seen from the pretest attitude scale result of 0.06 (low) to the posttest scale of 0.84 (high).

Even, further analysis of environmental awareness attitudes for each indicator shows various levels of increase, with low, medium, and high increase. For example, on attitudes related to concern, a high increase was obtained, with Rasch-gain (RG) = 2.46 (Nitta et al., 2019). This occurs since through PBL learning with video simulation assistance, students are able to experience the impact of disasters on their environment, which in turn demands that they learn to recognize hazards and risks around them, think of ways to prevent or minimize the impact of disasters, and find ways to help victims (Zhang et al., 2021; Zheng et al., 2021).

The same is true for the increase in constancy, which has a medium increase (RG = 1.36). Learning about disasters with video simulation-assisted problem-based learning invites students to see the impact of disasters and environmental changes, often caused by human actions. In addition, students are also invited to respond to and solve disaster problems that arise in an appropriate and measured way, thereby strengthening their skills and abilities in emergency situations caused by the disaster (Zheng et al., 2021).

The decrease in the low-level attitude of critical and curiosity is certainly interesting to be discussed. With RG = 0.07, the low level of critical attitude shows us that after the implementation of this learning, students may lack the necessary awareness and ability to question why this flood occurred. The low critical attitude is possible because the respondents considered the phenomenon of tidal floods in their environment to be a common occurrence that they experience almost every time, and this creates a sense of permissiveness and hopelessness, so they no longer need to question why it happened.

This explanation appears in the psychological theory proposed by Maier et al. (2016) which explains that people who experience constant failure will tend to feel hopeless and feel that they have no control over the situation. The similar explanation can also be understood in the decrease of students' curiosity attitudes (RG = -0.26), that the habit of students who constantly experience tidal floods affects their behaviour and attitudes towards environmental issues. This is in line with research conducted by Kang et al. (2021) which shows that people living in flood-prone areas tend to experience higher psychological fatigue, which can ultimately reduce their interest in environmental issues.

Nevertheless, on average, the scale of students' environmental awareness attitudes after the implementation of disaster learning with video simulation-assisted problem-based learning increased with a medium category (<RG> = 0.96). This is supported by the t-test, which produced t-value of 43.032, that is larger than t-table of 1.734. It indicates a significant increase in attitude scale before and after the implementation of the learning.

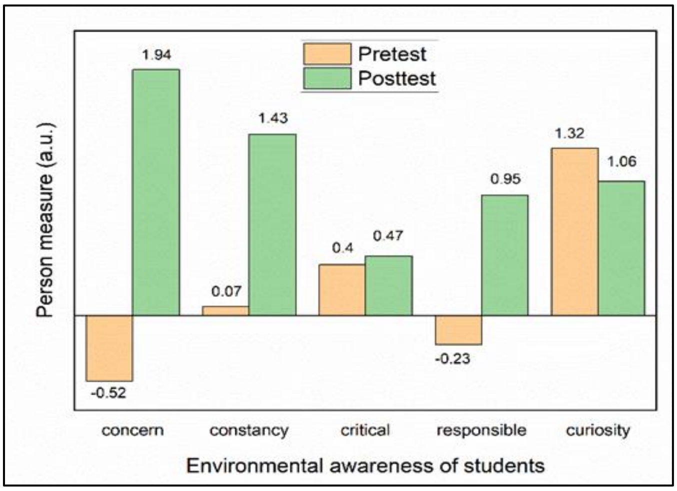

Figure 2. Student environmental awareness obtained from Rasch person measure.

In general, this study confirms several previous works conducted by several researchers. Seddighi et al. (2020) in their identification found that disaster education in schools is effective in increasing disaster awareness and mitigation, but it is not yet widely done in many countries. Further, Sudarmilah et al. (2019) found that the use of video game media technology in disaster education can be a more effective instrument, especially for children, in the disaster mitigation education process. In line with this, the result of the study by Jalaluddin et al. (2022) stated that an increase in cognitive learning outcomes after the application of a simulation learning model integrated into classroom learning can improve student affective learning outcomes.

Conclusion

Based on the presented research results and discussion, it can be concluded that there is an improvement in the knowledge of climate change and tidal flood disaster mitigation materials in for junior high school students who have received learning with simulation video assisted problem-based learning model. The increase of climate change knowledge was at moderate level, as evidenced by the N-gain value of 0.40. Likewise, the increase of tidal flood disaster mitigation knowledge was at moderate level, evidenced by the N-gain value of 0.37. As for environmental awareness, there was a significant increase in understanding, as shown by the person measure (Rasch model) score of 0.06 (low) in the pretest, and 0.84 (high) in the posttest.

References

Agustoni, A., Suratno, & Suparti. (2021). Development of Science Learning Devices Contexstual Problem Based Learning (CPBL) Based in Improving Problem Solving Skills for 4th Grade Elementary School. *Journal of Physics: Conference Series*, *1839*(1). https://doi.org/10.1088/1742-6596/1839/1/012029.

Agusty, A. I., Alifteria, F. A., & Anggaryani, M. (2021). STEM in Disaster Learning Media: A Literature Review. *Journal of Physics: Conference Series*, *2110*(1), 012016. https://doi.org/10.1088/1742-6596/2110/1/012016

Ali, K., & Ashmawy, A. K. (2019). Enhancing students' problem solving skills through integrative learning. *2018 World Engineering Education Forum - Global Engineering Deans Council, WEEF-GEDC 2018*, *10*(1), 74–87. https://doi.org/10.1109/WEEF-GEDC.2018.8629772

Atmojo, S., Rusilowati, A., Dwiningrum, S., & Skotnicka, M. (2018). The Reconstruction of Disaster Knowledge through Thematic Learning of Science, Environment, Technology, and Society Integrated with Local Wisdom. *Jurnal Pendidikan IPA Indonesia*, *7*(2), 204–13. https://doi.org/10.15294/jpii.v7i2.14273.

B.N.P.B. (2021). *Infografis Geoportal Data Bencana Indonesia BNPB September 2021*. Badan Nasional Penanggulangan Bencana.

Barclay, J., Haynes, K., Tom Mitchell, M. S., Teeuw, R., Amii Harwood, H. C., Cole, P., David Pyle, C. L., Fearnley, C., & Kelman, I. (2008). Framing Volcanic

Risk Communication within Disaster Risk Reduction: Finding Ways for the Social and Physical Sciences to Work Together. In *Geological Society* (Vol. 305, pp. 165–77). Special Publications.

Fai, R. (2018). Pengaruh Penggunaan Media Audio Visual Terhadap Pemahaman Konsep Mitigasi Bencana Pada Mahasiswa Pendidikan Geografi. *Jurnal Pendidikan Dan Pembelajaran*, *3*(1), 62–69. http://www.ojs.iptpisurakarta.org/index.php/Edudikara/article/view/79.

Fischer, T. B., Jha-Thakur, U., & Hayes, S. (2015). Environmental Impact Assessment and Strategic Environmental Assessment Research in the UK. *Journal of Environmental Assessment Policy and Management*, *17*(01), 1550016. https://doi.org/10.1142/S1464333215500167

Ikhwanudin, Wahyudi, S. I., & Soedarsono. (2020). Methods for Handling Rob Floods in the Banger River Basin in Semarang City. *Journal of Physics: Conference Series*, *1625*(1), 012041. https://doi.org/10.1088/1742-6596/1625/1/012041

Jalaluddin, W., & Rusilowati, A. (2022). Implementasi Model Pembelajaran Simulations Integrated Berbantuan Video Untuk Mitigasi Bencana Banjir Di Kabupaten Brebes. *UPEJ Unnes Physics Education Journal*, *11*(1), 36–43. https://doi.org/10.15294/UPEJ.V11I1.58875.

Kang, D.-H., Nam, D.-H., Jeung, S.-J., & Kim, B.-S. (2021). Impact Assessment of Flood Damage in Urban Areas Using RCP 8.5 Climate Change Scenarios and Building Inventory. *Water*, *13*(6), 756. https://doi.org/10.3390/w13060756

Khalaf, M. A., & Omara, E. M. N. (2022). Rasch Analysis and Differential Item Functioning of English Language Anxiety Scale (ELAS) across Sex in Egyptian Context. *BMC Psychology*, *10*(1). https://doi.org/10.1186/s40359-022-00955-w.

Khanal, S., Medasetti, U. S., Mashal, M., Savage, B., & Khadka, R. (2022). Virtual and Augmented Reality in the Disaster Management Technology: A Literature Review of the Past 11 years. *Frontiers in Virtual Reality*, 3. https://doi.org/10.3389/frvir.2022.843195

Kim, J. (2021). Development and Validation of the Career Adaptability Scale for Undergraduates in Korea. *Sustainability*, *13*(19), 11004. https://doi.org/10.3390/su131911004

Maier, S. F., & Seligman, M. E. P. (2016). Learned helplessness at fifty: Insights from neuroscience. *Psychological Review*, *123*(4), 349–367. https://doi.org/10.1037/rev0000033

Medriati, R., Risdianto, E., Purwanto, A., & Kusen, K. (2022). Rasch Model Analysis on the Development of Digital Learning Model Using MOOCs in Practical Courses at University. *AL-ISHLAH: Jurnal Pendidikan*, *14*(1), 269–82. https://doi.org/10.35445/alishlah.v14i1.1192.

Nickl, M., Huber, S. A., Sommerhoff, D., Codreanu, E., Ufer, S., & Seidel, T. (2022). Video-based simulations in teacher education: the role of learner characteristics as capacities for positive learning experiences and high performance. *International Journal of Educational Technology in Higher Education*, *19*(1), 45. https://doi.org/10.1186/s41239-022-00351-9

Nitta, H., & Aiba, T. (2019). An Alternative Learning Gain Based on the Rasch Model. *The Physics Educator*, *01*(01), 1950005. https://doi.org/10.1142/S2661339519500057

Qodrifuddin, T. A. A., Jumiati, K., Zulva, M., Mihratun, R. A., Utami, R. K., Cahyani, S., Aprialis, U., Safitri, B. N., Sayidah, W., & Raksun, A. (2022). Peningkatan Pemahaman Masyarakat Terhadap Bahaya Dan Dampak Bencana Alam Serta Penanggulangannya. *Jurnal Pengabdian Magister Pendidikan IPA*, *5*(1), 173–77. https://doi.org/10.29303/jpmpi.v5i1.1400.

Rahayu, S., Setyosari, P., Hidayat, A., & Kuswandi, D. (2022). The Effectiveness of Creative Problem Solving-Flipped Classroom for Enhancing Students' Creative Thinking Skills in Online Physics Educational Learning. *Jurnal Pendidikan IPA Indonesia*, *11*(4), 649–656. https://doi.org/10.15294/jpii.v11i4.39709.

Rajabi, M. S., Taghaddos, H., & Zahrai, S. M. (2022). Improving Emergency Training for Earthquakes through Immersive Virtual Environments and Anxiety Tests: A Case Study. *Buildings*, *12*(11), 1850. https://doi.org/10.3390/buildings12111850

Roy, K. C., Hasan, S., Abdul-Aziz, O. I., & Mozumder, P. (2022). Understanding the Influence of Multiple Information Sources on Risk Perception Dynamics and Evacuation Decisions: An Agent-Based Modeling Approach. *International Journal of Disaster Risk Reduction*, *82*(103328). https://doi.org/10.1016/j.ijdrr.2022.103328.

Rusilowati, A. (2018). Asesmen Literasi Sains: Analisis Karakteristik Instrumen dan Kemampuan Siswa Menggunakan Teori Tes Modern Rasch Model. *Prosiding Seminar Nasional Fisika Universitas Riau Ke-3*, *3*, 2–15. https://snf.fmipa.unri.ac.id/wp-content/uploads/2019/03/0.-300B-2-15NI.pdf

Rusilowati, A., Supriyadi, I. H., & Abidin, Z. (2020). Pengembangan Model Pembelajaran Simulation Integrated Untuk Mitigasi Bencana. In *Laporan Penelitian*. LPPM UNNES.

Seddighi, H., Sajjadi, H., Yousefzadeh, S., López López, M., Vameghi, M., Rafiey, H., Khankeh, H. R., & Garzon Fonseca, M. (2020). Students' preparedness for disasters in schools: a systematic review protocol. *BMJ Paediatrics Open*, *4*(1), e000913. https://doi.org/10.1136/bmjpo-2020-000913

Sheehy, K., Vackova, P., van Manen, S., Saragih Turnip, S., Rofiah, K., & Twiner, A. (2022). Inclusive disaster risk reduction education for Indonesian children. *International Journal of Inclusive Education*, 1–17. https://doi.org/10.1080/13603116.2022.2115156

Simsek, E., & Koseoglu, F. (2021). The effects of problem-based learning and simulation methods on pre-service teachers' disaster awareness and attitudes towards disaster education. *Journal of Education and Practice*, *12*(2), 24–32.

Suarmika, P. E., & Utama, E. G. (2017). Pendidikan Mitigasi Bencana Di Sekolah Dasar (Sebuah Kajian Analisis Etnopedagogi. *JPDI (Jurnal Pendidikan Dasar Indonesia)*, *2*(2). https://doi.org/10.26737/jpdi.v2i2.327.

Sudarmilah, E., Wahab, I. H. A., Putri, D. A. P., Pratisti, W. D., & Yuliana, I. (2019). Game education of disaster mitigation: A systematic literature review. *International Journal of Advanced Trends in Computer Science and Engineering*, *8*(6), 2940–2943. https://doi.org/10.30534/ijatcse/2019/42862019

Sumintono, B., & Widhiarso, W. (2015). *Aplikasi Pemodelan Rasch Pada Assessment Pendidikan*. Trim Komunikata. https://eprints.um.edu.my/14228/11 Februari 2023

Syafei, N. I., Muryani, C., & Rintayati, P. (2017). Analisis Sebaran, Dampak, dan Adaptasi Masyarakat Terhadap Banjir Rob di Kecamatan Semarang Timur dan Kecamatan Gayamsari Kota Semarang. *Jurnal GeoEco*, *3*(2), 145–156. https://jurnal.uns.ac.id/GeoEco/article/view/14310

Tanjung, S., Baharuddin, Ampera, D., Farihah, & Jahidin, I. (2022). Problem Based Learning (PBL) Model with Technological, Pedagogical, and Content Knowledge (TPACK) Approach. *International Journal of Education in Mathematics, Science and Technology*, *10*(3), 740–752. https://doi.org/10.46328/ijemst.2510

Tint, B. S., McWaters, V., & Driel, R. (2015). Applied Improvisation Training for Disaster Readiness and Response. *Journal of Humanitarian Logistics and Supply Chain Management*, *5*(1), 73–94. https://doi.org/10.1108/JHLSCM-12-2013-0043.

Tolppanen, S., Kang, J., & Riuttanen, L. (2022). Changes in students' knowledge, values, worldview, and willingness to take mitigative climate action after attending a course on holistic climate change education. *Journal of Cleaner Production*, *373*(133865), 133865. https://doi.org/10.1016/j.jclepro.2022.133865

Verawati, N. N. S. P., Hikmawati, & Prayogi, S. (2021). The Effectiveness of reflective-inquiry learning model to improve preservice-teachers' critical thinking ability viewed from cognitive style. *Journal of Physics: Conference Series*, *1747*(1), 012010. https://doi.org/10.1088/1742-6596/1747/1/012010

Wahyono, I. U., Kadek, A., & Untara, K. A. A. (2022). The Implementation of Local Context Modules as An Effort for Disaster Risk Reduction (An Empirical Study in Disaster-Affected Schools. *Jurnal Pendidikan IPA Indonesia*, *11*(3), 363–70. https://doi.org/10.15294/jpii.v11i3.37399.

Wahyuni, S., Mukminin, A., Lestari, U., & Mursid, R. (2019). The effect of problem-based learning on students' science literacy skills on disaster topic. *International Journal of Instruction*, *12*, 527–542.

Yamori, K., Kimura, Y., & Ohashi, H. (2018). The effectiveness of problem-based learning using a simulation game in disaster nursing education. *Nurse Education Today*, *69*, 60–65.

Zhang, F., Xu, Z., Yang, Y., Qi, M., & Zhang, H. (2021). Virtual reality-based evaluation of indoor earthquake safety actions for occupants. *Advanced Engineering Informatics*, *49*(101351), 101351. https://doi.org/10.1016/j.aei.2021.101351

Zheng, X., Song, Y., Li, X., Zhao, Z., Li, Y., & Pan, F. (2021). The effect of virtual reality technology on disaster education: A systematic review. *International Journal of Environmental Research and Public Health*, *18*(1), 134–143.

Zhou, W., & Zhang, Z. (2019). Validating a Chinese Version of the Multiple Intelligences Developmental Assessment Scales (MIDAS) Using Rasch Model Analysis. *Asia Pacific Education Review*, *20*, 645–54.