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DIFMOL: INDONESIAN STUDENTS' HOTS AND ENVIRONMENTAL EDUCATION MODEL DURING COVID-19

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Abstract: Flood issues will become aggrevated during the COVID-19 pandemic and solutions, especially in environmental education, must be developed to provide relief to affected communities. Students, as the generation who will shape society in future, must be able to contribute ideas to resolve environmental problems. One of the abilities that must be acquired to do so is Higher Order Thinking Skills (HOTS). This can be trained by developing a Disaster Mitigation of Floods Based on Online Learning (DIFMOL) education model. This study aims to develop a DIFMOL model to improve students' HOTS. The research method was adapted from Gall and Borg (2003). The results showed that all students had a very low score of HOTS (28.01), with the male level (28.02) being slightly higher than females (27.99). Meanwhile, the validation results showed that the DIFMOL model had a valid score. This suggested that the model may be used in learning during the COVID-19 pandemic. The DIFMOL model is a technology-based 21st-century learning innovation. The study concludes that the students' HOTS score was low and the DIFMOL model may be used to improve their skills.

Keywords: COVID-19, DIFMOL, HOTS.

Introduction

Flooding in cities is caused by environmental problems and it must be immediately resolved. Disaster mitigation is something that can be done to relieve the suffering in affected communities through various forms of technology (Crow & Albright, 2019; Farisi, 2016; Gampell *et al*., 2017; Harahap *et al*., 2018; Rahmayanti *et al*., 2018, 2019; Rahmayanti & Ananda, 2017; Seechaliao, 2017; Sipahutar *et al*., 2019; Siriwardena *et al*., 2013; Thompson, 2012; Tsai *et al*., 2015). The use of technology in 21st century learning is pivotal because it supports distance education. Education must reach all regions, so that access to information is not limited to schools and universities only.

Information regarding disaster mitigation can be disseminated through websites and smartphone applications (Glynn *et al*., 2007; Reyna *et al*., 2018, 2019). The community, in this case students, are expected to know how to respond in the event of a flood. Floods are a perenial problem in urban areas, thus improvement of community knowledge on how to mitigate the disaster is important to ensure safety and survival. The COVID-19 pandemic has aggrevated the flood problem in many communities. However, one component of society that can make a change in this case are school and university students, who can be easily equipped with Higher Order Thinking Skills (HOTS) to contribute to their communities.

HOTS refers to a person's ability to analyze a problem, carry out an evaluation and come up with solutions (Aldig & Arseven, 2017; Dahl *et al*., 2018; Deschryver, 2017; Dwyer *et al*., 2014; Ichsan *et al*., 2019; Khoiriyah & Husamah, 2018; Khuana *et al*., 2017). HOTS is indispensable as various environmental problems, including floods, require HOTS to respond in the best

mitigative way. Environmental education roles will become crucial to improve HOTS in the context of flood disaster mitigation. Enhancement in HOTS requires innovations in 21st-century education, one of which is through the development of models. Students need more training to improve their HOTS as the learning environment in school is considered insufficient.

Research in various countries have shown that HOTS is one of the abilities needed in 21st-century learning (Camacho & Legare, 2015; Husamah *et al*., 2018; Ichsan *et al*., 2020; Quieng *et al*., 2015; Saputri *et al*., 2019; Urbani *et al*., 2017). It is also required in disaster mitigation learning. Another research on HOTS stated that this ability may be improved through various strategies. One educational innovation that is developed in this study is the Disaster Mitigation of Flood Based on Online Learning (DIFMOL) model. This model is a form of novelty in terms of technology-based environmental education.

As floods continue to plague communities during the COVID-19 pandemic, DIFMOL can still be used depite other learning activities being disrupted by measures taken to contain infection. Students will find it difficult to attend classes due to physical distancing being enforced by the authorities. As a consequence, learning at home will become vital. For this to happen, the Internet and education infrastructure must be well prepared. The purpose of this study is to analyze students' HOTS and develop a DIFMOL educational model.

Method

This research was adapted from the model by Gall and Borg (2003) and was conducted from March to April 2020. Participating students were selected randomly using a simple random sampling method in several Indonesian cities, namely Jakarta, Semarang, Riau Islands, Pontianak and Makassar. The respondents comprised 504 university students (157 males and 347 females).

The study conisted of the following stages: (1) analyzing the students' HOTS; (2) designing the DIFMOL education model; (3) developing the DIFMOL Syntax Model; (4) developing the DIFMOL model products; and, (5) implementing the products. This paper featured only until the third stage. This was because the implementation of stage four onwards would be carried out separately to maximize the effectiveness of the DIFMOL product test. Thus, the DIFMOL product effectiveness test would be carried out through an experimental method in further research. Following the development of the DIFMOL syntax, expert validation was carried out by four lecturers and five teachers. Validation scores were then interpreted according to the following categories in Table 1.

Table 1: Interval scores and validity categories of the DIFMOL Model

Validation Score Interval	Validation Category
$3{,}25 < x \leq 4{,}00$	Very Valid
$2{,}50 \leq x \leq 3{,}25$	Valid
$1{,}75 < x < 2{,}50$	Less Valid
$1{,}00 < x < 1{,}75$	Not Valid

Source: Ratumanan & Laurens (2006)

Once HOTS had been measured in the first research step, the following data would be interpreted according to the HOTS categories. In general, they were divided into five categories, namely very high, high, moderate, low and very low. Details of the HOTS categories are stated in Table 2.

Table 2: Student's HOTS score categories

Categories	Interval Score
Very High	$X > 81{,}28$
High	$70{,}64 < X \leq 81{,}28$
Moderate	$49{,}36 < X \leq 70{,}64$
Low	$38{,}72 < X \leq 49{,}36$
Very Low	$X \leq 38{,}72$

Source: Adapted From Ichsan *et al*. (2019)

Results and Discussion

The results in Table 3 shows that the participating students' overall HOTS scores were the lowest in the item of analyzing the impact of river normalization on the surrounding community. This indicated that the students needed to improve their analytical skills. The average HOTS score on other items are stated in Table 3.

The lowest-scored item might be a weak aspect due to limited information about the impact of river normalization. The limitation was related to the normalization process of river sedimentation that required a long time. Thereore, the information about its impact would become complicated in the analysis, in which the details could be seen in Table 4.

The results suggested that based on the HOTS aspect, the lowest average HOTS score was to analyze (C4) as indicated in Table 5. This should be be addressed immediately as it was a vital aspect for them to be able to participate in solving various environmental issues.

Table 3: Average students' HOTS score based on items

No	Item	All (n=504)	Male (n=157)	Female (n=347)
1	Analyze policies for rivers normalization in the context of flood prevention	2.72	2.77	2.70
2	Analyze the impact of rivers normalization on the surrounding community	2.40	2.44	2.39
3	Analyze the use of plastic bags and their impacts on floods amid the COVID-19 outbreak	3.11	3.03	3.14
4	Analyze the effectiveness of paid-plastic policies and solutions to these problems during the COVID-19 outbreak	2.87	2.76	2.91
5	Criticize communities that do not have green areas (parks).	2.63	2.56	2.66
6	Provide solutions and opinions so that the target green area can be achieved	2.66	2.68	2.65
7	Criticize about drainage channel and its impact on the spread of COVID-19	2.94	2.96	2.93
8	Criticize floods caused by the accumulation of garbage impact on the spread of COVID-19	2.98	2.93	3.01
9	Create a program to prevent floods in the environment around the often-flooded areas	2.96	3.04	2.93
10	Create an innovative program for maintaining cleanliness implementation	2.49	2.58	2.44
11	Make a resume containing invitations and facts about the importance of preventing floods to maintain health and minimize the spread of COVID-19	3.06	3.01	3.07
12	Create an innovative program so that people want to prevent floods, especially during the pandemic COVID-19	2.79	2.86	2.76
Raw Score		33.61	33.62	33.59
Average Score (0-100)		28.01	28.02	27.99
Category		Very Low	Very Low	Very Low

Table 4: Average students' HOTS score based on indicator

No.	Indicators	All (n=504)	Male (n=157)	Female (n=347)
1	Analyze the impacts of river normalization programs to prevent floods	2.56	2.61	2.54
2	Analyze the impact of using plastic bags related to floods during the COVID-19 outbreak	2.99	2.89	3.03
3	Evaluate the effectiveness of expanding green areas in urban as water absorption areas	2.65	2.62	2.66
4	Criticize drainage in densely populated homes to prevent floods and COVID-19	2.96	2.95	2.97
5	Create a program to encourage other students to prevent floods	2.72	2.81	2.68
6	Create a design of activities for the community to prevent floods and COVID-19 transmission	2.92	2.94	2.91

Table 5: Average students' HOTS score based on their aspects

No	Aspect	All (n=504)	Male (n=157)	Female (n=347)
1	Analyze	2.77	2.75	2.79
2	Evaluate	2.81	2.78	2.81
3	Create	2.82	2.87	2.80

After implementing the model, the syntax development must be conducted. The results of the DIFMOL model development was three syntax/learning steps. The development results indicated that the model could be used for a variety of levels, from elementary school to higher education. Details of syntax, lecturer activities and student activities are stated in Table 6.

Table 6: Syntax (Learning Stages) of DIFMOL Model

No	Syntax	Lecturer activities	Student Activities
1	Discovering Disaster Problem	The lecturer facilitates students to discover various disasters, in this context the problem is floods.	Students discover disaster problems, especially flood problems and then write a brief description of the problem on online learning media.
2	Discussing Problem	The lecturer asks students to discuss on online learning media (Google Classroom, WhatsApp Group, etc.).	Students conduct discussions on online learning media. Students must ask questions and discuss with other students.
3	Designing a Solution to the Problem	The lecturer asks students to innovate and solve the problems. Students were asked to express these solutions on the online learning media.	Students design problem solutions and write these problem solutions on the online learning media.

After validation by the lectures and teachers, the results showed that the DIFMOL model had a valid category. This showed that the model could be used in learning at schools and universities. Moreover, the validation results suggested that the model was a learning innovation that followed the aspects of 21st century learning that was based on HOTS.

The results showed that the students' HOTS scores were in very low category. It indicated the lack of disaster management lessons up to the university level. Students' HOTS were also still lacking to allow them to overcome various problems that occurred relating to floods during the COVID-19 pandemic. Students, as a younger generation and rising component of society, should be able to actively contribute their innovative ideas to resolve environmental problems through the improvement of HOTS.

The DIFMOL Model is essentially an online-based education model, hence, all learning tools developed were digitally based and could be used by students for learning. It is depicted more clearly in Figure 1.

Based on the results of validators' assessment, the DIFMOL model was valid and suitable for use in learning. It was known that syntax from the developed model prioritized HOTS. This was indicated in the last syntax, which was related to creating a solution to the problem. It was in accordance with one aspect of HOTS, namely, to create (C6). This ability should be focused on the student level as they must be capable of providing solutions to all kinds of problems. The ability to think creatively is one of the most important in the 21st century (Khoiriyah & Husamah, 2018; Latta *et al*., 2017; Oncu, 2016; Rahmayanti *et al*., 2020; Santi *et al*., 2019; Seechaliao, 2017; Winarno *et al*., 2017; Wojciehowski & Ernst, 2018).

Table 7: DIFMOL Model Scores by validators

Validators	21st century aspect	HOTS aspect	All aspects
Lecture 1	3.40	4.00	3.70
Lecture 2	3.60	3.00	3.30
Lecture 3	3.60	3.80	3.70
Lecture 4	4.00	4.00	4.00
Teacher 1	3.80	3.40	3.60
Teacher 2	3.80	3.80	3.80
Teacher 3	4.00	4.00	4.00
Teacher 4	3.80	4.00	3.90
Teacher 5	3.40	3.40	3.40
Average Score	3.71	3.71	3.71
Category	Very Valid	Very Valid	Very Valid

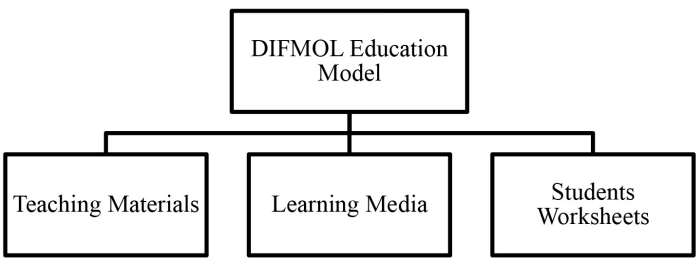

Figure 1: The DIFMOL learning tools consist of teaching materials, learning media, and student worksheets

The students' ability to create could help solve various flood problems that occured in their neighborhoods. The DIFMOL model, in this case, could support the creation of these capabilities. In addition, other efforts were needed to support the model's utilization in learning about disasters, especially floods. Other efforts could be made through the development of various supporting learning media and student worksheets to enhance its effectiveness (Atasoy & Ergin, 2017; Calado *et al*., 2018; Daumiller & Dresel, 2018; Evans, 2014; Jewpanich & Piriyasurawong, 2015; Mao, 2014; Miarsyah *et al*., 2019; Nugraini *et al*., 2013; Sigit *et al*., 2019; Yousefi, 2014).

Learning innovation in the 21st century is required especially to develop a variety of abilities in all situations (Arthur *et al*., 2019; Farisi, 2016; Ichsan & Rahmayanti, 2020; Kivunja, 2015; Nissim *et al*., 2016; Reyna *et al*., 2018; Sigit *et al*., 2020; Yang, 2018). These abilities were necessary so students could graduate as a society that could compete in a global stage. The existence of HOTS was expected to improve the students' analytical capabilities so they could become role models in resolving various problems related to the environment. The DIFMOL model is one solution to the problem of difficulty in carrying out learning during the COVID-19 pandemic, since it was an educational model that utilised online learning. It corresponded to policies of various countries to implement physical distancing as the "new normal" and could be very useful to ensure that education, particularly higher education, could go on as usual. The use of technology had become a necessity in the 21st century. The DIFMOL model is a form of innovation in technology-based 21st-century education. This learning innovation would help teachers and lecturers deliver various materials to enrich their students' learning experience (Baloche & Brody, 2017; Chanlin *et al*., 2016; Farisi, 2016; Paristiowati *et al*., 2019; Saade *et al*., 2012; Sahronih *et al*., 2019; Said & Syarif, 2016; Sharif & Cho, 2015; Tkachuck *et al*., 2018; Wihardjo *et al*., 2020; Winarno *et al*., 2017). The utilization of the DIFMOL model should studied for application in various online learning platforms, such as Google Classroom, WhatsApp and others.

Conclusion

Despite the low HOTS scores among students involved, this study on the first three stages of the DIFMOL model indicated that it had the potential to increase the skill related to flood knowledge and mitigating its impact. It is proposed to develop learning products based on the DIFMOL model so that it could be effectively implemented in environmental education at various levels of learning.

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