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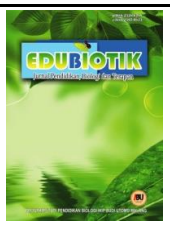

Research Article

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Predicting environmental problem-solving skills with a dynamic system in elementary education

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ABSTRACT

Numerous environmental problems drive discussion to solve them. Students require environmental problem-solving skills to solve the existing problems. The study aimed to describe environmental problem-solving skills in Elementary Education. The research method is descriptive using a dynamic system approach. Instrument of Higher Order Thinking Skills (HOTS) and Pro-Environmental Behavior (PEB) used to measure students score in environmental topic. Sample was chosen by simple random sampling. The research used VENSIM software to create the modeling. The research results indicate that the score of the environmental problem-solving skills tends to increase due to the Higher Order Thinking Skills (HOTS) and Pro-Environmental Behavior (PEB). Moreover, there are other influencing factors including learning media and students' activity in their environment. An increase of 5 points in the environmental problem-solving skills every year will be derived if the teachers perform various learning innovations. The research concludes that environmental problem-solving skills in low category and can be improve by various learning innovations.

Keywords: Dynamic system; environmental problem-solving skills

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INTRODUCTION

Numerous environmental problems have triggered studies using various scientific approaches started from the environmental science that studies phenomena based on environmental factors. Additionally, other studies are required, for example, education science that views environmental problems in terms of their prevention through various ways of education. The various ways of education conducted by teachers and lecturers in different educational institutions will help in preventing various environmental problems. Students' skills, in this case, that can be a benchmark are environmental problem-solving skills (Seechaliao, 2017; Vidergor & Krupnik-Gottlieb, 2015; Vogelaar & Resing, 2018). Environmental Problem solving skills will make students having various ideas to solve environmental problems, because this ability teaches students to be able to analyze various problems and then try to solve the problem (Bowden, 2019).

Different methods are available to develop the environmental problem-solving skills that include the Higher Order Thinking Skills (HOTS) and linked it with Pro-Environmental Behavior (PEB) because it related (Ichsan et al., 2020). One concern, however, is related to the effectiveness of the diverse learning media and environmental activities in the formation of the HOTS and PEB and it is indirectly related to the environmental problem-solving skills (Santi et al., 2019). Previous studies have explained that learning media directly affect HOTS (Athreya & Mouza, 2017; Garcia, 2015; Gil-Glazer et al., 2019). Habits and environmental activities also affect PEB. Therefore, environmental problem-solving skills can be predicted using a dynamic system approach.

The dynamic system serves to predict the amount of increase or decrease of a variable as a whole. The variables that become the center of development are related to the environmental problem-solving skills. The dynamic system can be used to predict various focus to solve the problem (Baradaran & Keshavarz, 2015; Eker et al., 2018; Jackson, 2001). It can only predict and the prediction, however, can be wrong. Therefore, it is not the only reference to decide on education. In this case, however, the use of the dynamic system will assist in determining the direction of education development for elementary education (elementary and secondary school). The novelty of this research is the use of a dynamic system to describe all the factors that might support the formation of Environmental Problem-Solving Skills.

Based on the aforementioned, it is necessary to perform several studies related to environmental problem-solving skills using a dynamic system. The research is urgent to create effective learning activities in developing environmental problem-solving skills to improve the skills of elementary and secondary school students. The dynamic system approach is beneficial for the formation of environmental problem-solving skills and the creation of learning that is more focused and in accordance with the set planning. Therefore, the research aimed to describe environmental problem-solving skills by using a dynamic system for elementary and secondary school students

RESEARCH METHODS

The research was descriptive research that used a dynamic system technique. The research used VENSIM software. The dynamic system is a method used to predict an event or variable in the next few periods. The current research predicted environmental problem-solving skills caused by several factors. The dynamic system could describe and make the prediction the amount of increase and decrease in the environmental problem-solving skills. The population of this study were all elementary and junior high school students in South Tambun, Bekasi. The samples used were 40 elementary school students and 40 junior high school students who were randomly selected. The instruments used are in the form of test items used to measure HOTS and a questionnaire used to measure PEB. The HOTS category used refers

to Anderson et al. (2001) which consists of 3 aspects, namely analyze, evaluate, and create. Meanwhile, the PEB instrument used is by referring to Kaiser & Wilson, (2004) which consists of 6 aspects, namely energy conservation, transportation, waste avoidance, consumerism, recycling, social behavior. The results of the average HOTS and PEB scores were then analyzed and interpreted in Table form. The data entered in the VENSIM PLE x64 software were related to the minimum of the initial score of students' HOTS, pro-environmental behavior score, and variations in the learning media utilization. VENSIM PLE software in this research can describe, analyze data and create Causal Loop Diagtam (CLD) and Stock Flow Diagram (SFD).

FINDING AND DISCUSSION

The research resulted in a Causal Loop Diagram (CLD) as illustrated in Figure 1. The CLD is the output of VENSIM. Model in Figure 1 is a model of environmental problem-solving skills formation for elementary and secondary school students. The positive sign (+) indicates that the variable has a positive effect on other variables. The negative sign (-) indicates that the variable has a negative effect on other variables.

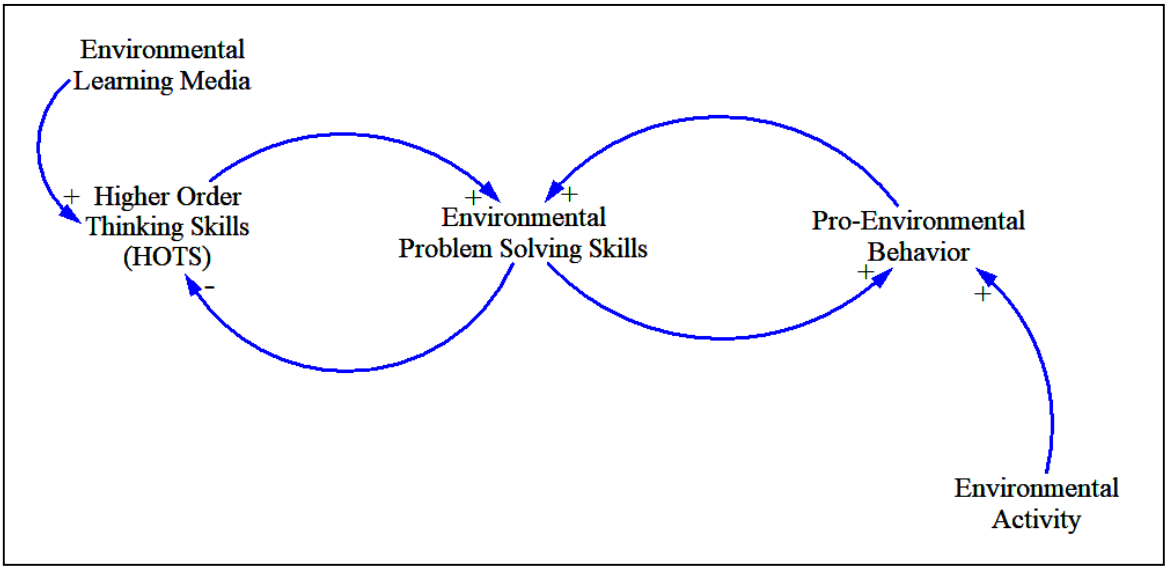

Figure 1. Causal Loop Diagram (CLD) of Environmental Problem-Solving Skills Formation Model

Next, a Stock Flow Diagram (SFD) was developed to observe the input and output of the system. The SFD development result for the environmental problem-solving skills formation model can be seen in Figure 2. The positive sign (+) indicates that the variable has a positive effect on other variables. The negative sign (-) indicates that the variable has a negative effect on other variables.

The result of running using the VENSIM application suggests that the environmental problem-solving skills had an increasing trend. This occurs if the utilization of learning media and students' activities has a positive score. The graph of the increase in the environmental problem-solving skill score is illustrated in Figure 3.

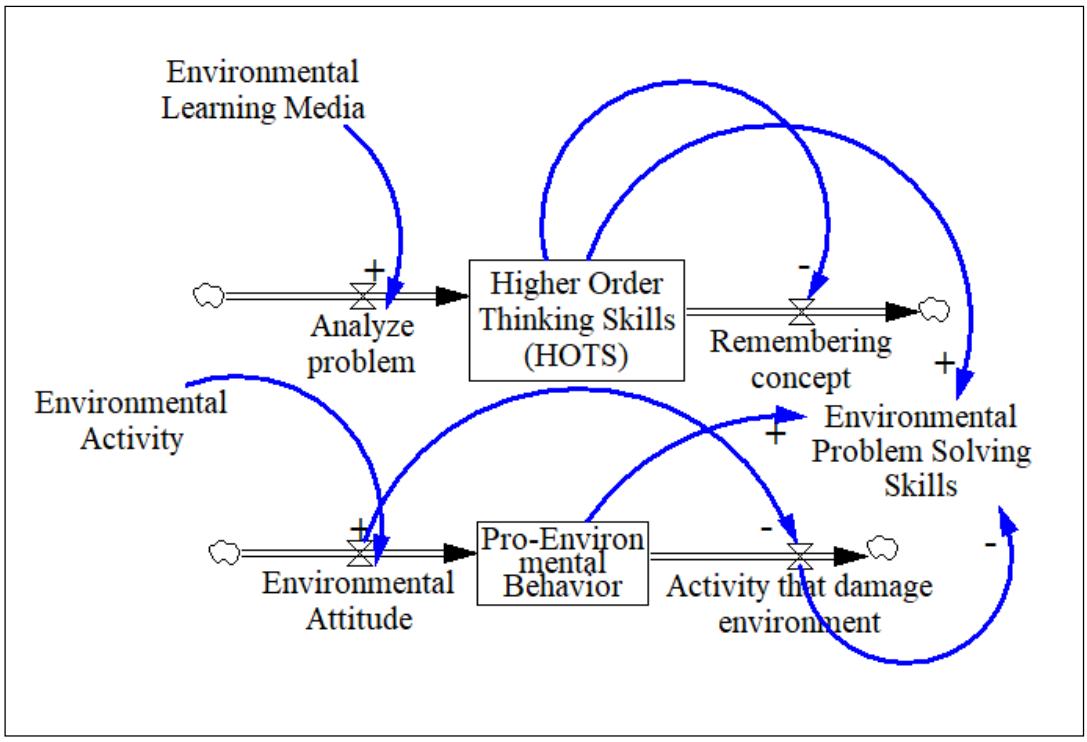

Figure 2. Stock Flow Diagram (SFD) of Environmental Problem-Solving Skills Formation Model

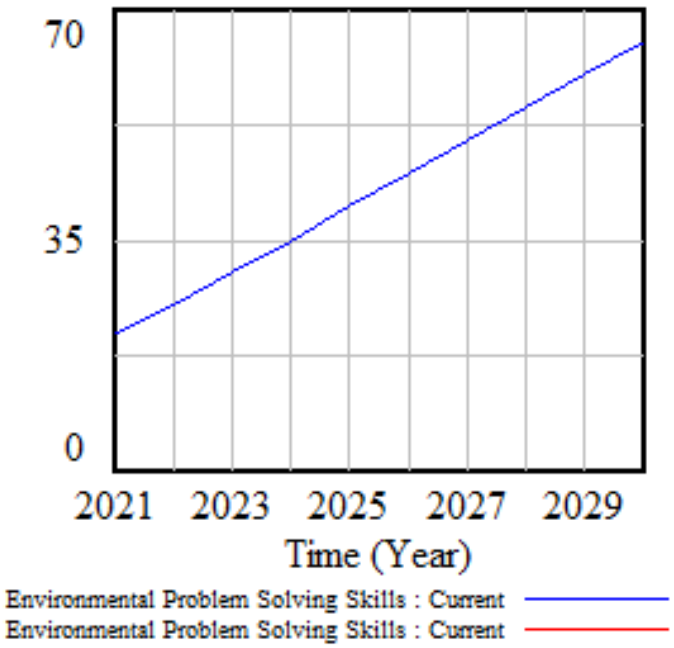

Figure 3. Result of Running of Environmental Problem-Solving Skills Formation Model

Detail results presented in a table suggest that there was an increase of 5 points score of students Environemntal problem solving skills for every year in 10 years (Table 1). The increase had a positive impact on the trend of environmental problem-solving skills. Consideration should be put on the following: teacher should be consistent in teaching and continue to develop learning media and equip students with environmental-based activities.

Table 1. Result of Running of The Environmental Problem-Solving Skills Formation Model

Year	Environmental Problem-Solving Skills Score
2021	21
2022	25
2023	30
2024	35
2025	40
2026	45
2027	50
2028	55
2029	60
2030	65

The research results indicate that environmental problem-solving skills require innovation in learning media (see Figure 2). This is illustrated in the results of CLD and SFD that suggest a link between learning media and HOTS. This is consistent with previous studies indicating that students' HOTS can be improved using various learning media and learning models (Husamah et al., 2018; Lee, 2016; Miarsyah et al., 2019; Urbani et al., 2017). The media could facilitate teachers and students of elementary and secondary schools to implement classroom learning.

Moreover, the CLD and SFD also illustrate that environmental activities affect PEB. This is consistent with previous studies suggesting that environmental activities have a sufficient contribution to the improvement of sustainable development-based programs. The activities should be promoted to students through various environmental activities to create sustainable development. The direction of the environmental activities will lead students to understand diverse concepts of environmentally friendly cities (Cavalheiro et al., 2019; Hu & Zheng, 2020; Lodato et al., 2018; Najim & Salman, 2020; Piyapong, 2019).

The HOTS and PEB play a vital role in improving environmental problem-solving skills. Therefore, a learning approach created must be based on the improvement of the HOTS and PEB. The topics discussed should be contextual so the teachers of natural science subject could understand the topics well. The HOTS can occur if teachers play a role of a facilitator. It is necessary to improve the HOTS through various learning innovations (Abidinsyah et al., 2019; Heong et al., 2012; Istiyono et al., 2020; Murtonen & Ballo, 2019; Rochman & Hartoyo, 2018; Tajudin & Chinnappan, 2016). This is especially for elementary and secondary education levels that require guidance from teachers. The description of the environmental problem-solving skills improvement thus can be achieved.

The use of learning media is very useful for increasing HOTS in basic education. This is because students find it easier to understand various environmental topics. This will have an impact on increasing HOTS. After increasing HOTS will have an impact on changes in student behavior. Of course, the dynamic system described in this study is only a prediction and is not completely accurate. Predictions from dynamic systems may not match the reality at school. This is because in schools there will be a lot of changes in learning situations that are influenced by other factors (Sandberg & Ohman, 2011; Yesiltas, 2016).

CONCLUSION

The research concludes that environmental problem-solving skills in low category and can be improve by various learning innovations. Therefore, teachers must be able to innovate in learning media and supporting environmental activities that support the trend. Teachers must be capable of facilitating students so that they are not trapped in conventional learning. Students must be more active in learning to bring their skills up.

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