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Application of Scientific-Based Electronic Natural Sciences Module to Improve Learning Outcomes in Knowledge Aspects of Vibration and Wave Materials in a Pandemic Period

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Abstract: *The COVID-19 pandemic has changed various aspects of human life today, especially in education, which requires all elements of education to keep the classroom active, even though it is done online. For this reason, this study aims to determine the effect of applying scientific-based electronic natural science modules to improve learning outcomes in aspects of students' knowledge of vibration and wave material. The method used was an experimental method with a posttest-only control group design. The data collection instrument employed was multiple-choice test questions totaling 20 items. The sample in this study consisted of 30 students in the experimental class and 30 students in the control class. The data analysis utilized was in the Mann-Whitney U test to determine the differences in the mean posttest score between the experimental and control classes. The results revealed that the learning outcomes of the knowledge aspect in the experimental class were better than the control class. Based on the descriptive analysis results, the mean posttest score of the experimental class was higher than the control class. In addition, the application of scientific-based electronic natural science modules improves the learning outcomes of students' knowledge aspects better.*

Keywords: *Learning Outcomes of Knowledge Aspect, Electronic Module, Pandemic, Scientific*

Abstrak: Pandemic Covid-19 telah mengubah berbagai aspek kehidupan manusia saat ini, khususnya dalam dunia pendidikan yang mengharuskan segala elemen pendidikan mempertahankan kelas tetap aktif meskipun dilakukan secara daring. Penelitian ini bertujuan untuk mengetahui pengaruh penerapan modul IPA elektronik berbasis Saintifik untuk meningkatkan hasil belajar aspek pengetahuan siswa pada materi getaran dan gelombang. Metode yang digunakan yaitu metode eksperimen dengan desain *posttest only control group design*. Instrumen pengumpulan data yang digunakan yaitu soal test pilihan ganda berjumlah 20 butir. Sampel dalam penelitian ini terdiri dari 30 siswa di kelas eksperimen dan 30 siswa di kelas kontrol. Analisis data yang digunakan berupa uji Mann-WhitneyU untuk mengetahui perbedaan rata-rata skor *posttest* antara kelas eksperimen dan kontrol. Hasil penelitian menunjukkan bahwa hasil belajar aspek pengetahuan kelas eksperimen lebih baik daripada kelas kontrol. Hal ini berdasarkan hasil analisis deskriptif rata-rata nilai *posttest* kelas eksperimen lebih tinggi dibanding kelas kontrol. Penerapan modul IPA elektronik berbasis Saintifik lebih baik meningkatkan hasil belajar aspek pengetahuan siswa.

Kata Kunci: Hasil Belajar Aspek Pengetahuan, Modul Elektonik, Pandemic, Saintifik

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INTRODUCTION

The COVID-19 pandemic has changed various aspects of human life today, especially in education, which requires all elements of education to maintain an active class, even though it is done online. The COVID-19 pandemic also urges distance education testing, which has never been done simultaneously before (Sun et al., 2020), for all elements of education, including students, teachers, and parents. Considering that time, location, and distance are big problems today during the pandemic (Kusuma & Hamidah, 2020). Thus, distance learning is a solution to overcome difficulties in carrying out face-to-face learning. However, it poses a challenge to all elements and levels of education to keep classes active, even though schools have closed. Suddenly, the COVID-19 pandemic requires educational elements to maintain online learning. Current conditions are also urgent for innovation and adaptation related to using available technology to support the learning process (Ahmed et al., 2020). In the current face-to-face learning process, students do not understand the material presented in learning (Malyana, 2020). The conditions for implementing distance education are different from those during learning before the pandemic (Asmuni, 2020; Basar et al., 2021; Yoga Purandina & Astra Winaya, 2020). Although teachers already own facilities, such as computers or laptops, they cannot develop an electronic book yet (Nakayama, M & Yamamoto, 2006; Szép, 2017).

The observation results carried out in schools revealed that the problem in the learning process was the limitations of learning media. In learning natural sciences, there were two learning media used in junior high schools: books from the Ministry of Education and Culture and modules from the MGMP [Teacher Working Group]. However, this MGMP module only contained short material and practice questions, such as student activity sheets. It made students sometimes still had difficulty understanding a given material, especially in distance learning conditions.

In general, learning media are everything that can be used as a tool in the teaching and learning process. In addition, teaching materials have a vital role in the aspect of education, one of which is in learning. The teaching materials can be combined with student situations and conditions, student characteristics, and material delivered in the learning process. It indicates that the electronic module plays an essential role in learning (Mustika, 2015). Learning media also plays a crucial role in the success of student learning. Efforts can be made to improve material mastery, one of which is the use of additional learning media, such as modules. However, using electronic learning modules that have not been carried out optimally causes a lack of student interest in learning. In this case, the learning module is a form of teaching material regarding a particular unit of discussion, arranged systematically, operationally, and directed, which is used by students, accompanied by guidelines for its use for teachers (Depdiknas, 2008). The use of electronic modules is also expected to make it easier for students to study independently. It is under the current state of the COVID-19 pandemic, which makes students have to study from home.

Based on observations made at junior high schools in Surakarta City, another obstacle that arose in the teaching and learning process that researchers obtained from one of the natural science subject teachers was that the class VIII students' learning outcomes had not met the KKM (minimum completeness criteria) score, namely 75. It was proven from the results that of 30 students, 10% of students had met the KKM score, while 90% of students had not met the KKM, especially in the basic competence (KD) of vibration and waves. In addition, the facts on the ground uncovered that many teachers, who had already had a good mastery of subject matter, especially natural sciences, had not been implemented the learning well. It happened because the learning process was not based on the determination and application of appropriate learning models, and learning was still oriented to the teacher as the primary knowledge source; thus, the students' learning outcomes were low.

Preferably, learning natural sciences emphasizes providing direct experience to students to train them to develop higher-order thinking skills. Characteristics of natural science learning include observation, making conclusions based on data, and formulating hypotheses (Galton & Eggleston, 1979). The learning experience gained in the classroom can be arranged depending on the scenario used by the teacher according to the lesson plan (Faour H, 2012, Qureshi, S & Ullah, R; Patricia m. King, 2014). Currently, various learning approaches are applied to help teachers accommodate students in developing higher-order thinking skills to improve student learning outcomes. One of the learning models that can condition students to play an active role is the scientific learning approach. According to Hosnan (2014: 34), the scientific approach is intended to provide understanding to students in recognizing and understanding various materials using a scientific approach, and that information can come from anywhere and anytime, not depending on one-way information from the teacher.

Moreover, one of the solutions to overcome the problems above is to use scientific-based electronic natural science modules. A module is a learning tool that contains material, method limitations, and ways of evaluating, designed systematically and attractively to achieve competence, which is expected to be in accordance with the level of complexity. Modules are also structured to help students learn something, make it easier for educators to teach something, and make learning activities more interesting (Depdiknas, 2008). In addition, the self-instructional nature of the module will help students during the current COVID-19 pandemic so that students can learn independently and not depend on other parties (Mustaji, 2008). Furthermore, electronic modules are defined as interactive teaching materials designed in various forms so that they are not monotonous, attracting students' interest in learning (Imansari & Sunaryantiningsih, 2017; Winatha et al., 2018). Electronic modules have the advantage of being able to increase the learning effectiveness and flexibility (Santosa, 2011; Surjono, 2009), not related to space and time (Gozali & Lo, 2012; Suwasono, 2013), and can make the learning process more interesting and not get bored quickly as e-modules are equipped with various images, videos, and interesting features, which can increase students' motivation in learning (Depdiknas, 2008). On the other hand, according to Hosnan (2014: 34), the scientific approach is a learning process designed in such a way that students actively construct concepts, laws, or principles through the stages of observing (identifying or finding problems), formulating problems, proposing or formulating hypotheses, collecting data using various techniques, analyzing data, drawing conclusions, and communicating concepts, laws, or principles found.

Previous research conducted by Ditasari (2013) showed that developing an integrated natural science module could improve student learning outcomes on environmental impact materials. In addition, a study carried out by Idrus (2020) revealed that scientific-based natural science learning could improve learning activities and student learning outcomes on the senses. Research by Putri (2021) also disclosed that the use of electronic modules could increase learning independence during the pandemic of water cycle material. Based on the description above, this study aims to determine the effect of implementing the scientific-based electronic natural science module in improving the learning outcomes of students' knowledge of vibration and wave material.

RESEARCH METHODS

The method used was an experimental method with a posttest-only control group design. This design aims to select two groups randomly from the existing population (Sugiyono, 2013). The first group in the experimental class was given treatment, then measured learning outcomes in the knowledge aspect, while the second group in the control class was not given treatment but only

measured learning outcomes in the knowledge aspect. The data collection instrument employed was multiple-choice test questions totaling 20 items. Before the test questions were used for research, the test questions prepared were tested first. The quality of the measuring instrument for learning outcomes in the knowledge aspect was determined by several factors, including (1) reliability test, (2) difficulty level, and (3) test discriminatory power (Azwar, 2000). The sample in this study amounted to 60 people, divided into 30 people in the experimental class and 30 people in the control class. The data analysis technique utilized was a prerequisite test (normality and homogeneity) because the data were not normally distributed, although a homogeneous distribution was met. Therefore, the next test used non-parametric statistics, a further test using the Mann-Whitney U test to find out the mean posttest score between the experimental and control classes.

RESULTS AND DISCUSSION

The analysis to determine the equivalence of students' knowledge of the two classes before carrying out the learning was tested utilizing SPSS 20 for windows, which began with prerequisite tests: normality test, homogeneity test, and Mann-Whitney U test using the previous daily test scores. The summary of normality, homogeneity and Mann-Whitney U tests for control and experimental class scores can be seen in Table 1.

Table 1. Recapitulation of Mean Discrimination Test Results between Experimental and Control Classes

Test	Results		Conclusion
Normality (Kolmogorov Smirnov)	Experiment Class	0.049 < 0.005	Not normal
	Control Class	0.044 < 0.005	Not normal
Homogeneity (Levene Statistics)	*Sig.* 0.102 > 0.05		Homogeneous
Mann-Whitney U test	*Sig.* 0.583 > 0.05		There is no significant difference.

From Table 1, it is known that the data were not normally distributed, although a homogeneous distribution was met. Based on the prerequisite test, the hypothesis test used was a non-parametric statistical test, namely the Mann-Whitney U test. According to the learning outcomes assessment on the aspect of knowledge obtained from the previous daily test scores, the control and experimental classes showed the same conditions. Besides, the Mann-Whitney U test obtained the level of sig. 0.583 > 0.05. Hence, in conclusion, there was no significant difference in the daily test scores of the previous material from the two groups, implying that both student classes had equal knowledge before participating in learning activities.

In this study, natural science learning using a scientific-based electronic natural science module was carried out based on discovery, which was obtained from a series of investigation processes. In the implementation process, students learned independently because they adapted health protocols during the COVID-19 pandemic, which required them to study from home. In this learning process, the teacher acted as a monitor, facilitator, and evaluator in student involvement in learning (Barthlow and Watson, 2011). As a learning facilitator, the teacher assisted students in finding facts and concepts. Concepts were not given explicitly, but the teacher encouraged and urged students to make conclusions and predictions.

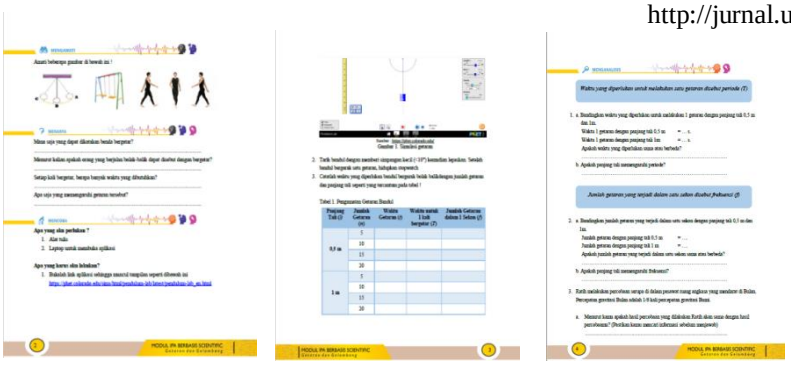

Figure 1. The Display of the Natural Science Module Contents

The subsequent measurement was carried out after the experimental group was given learning treatment using a scientific-based electronic natural science module and the control group without using it. Six meetings were conducted online on the same teaching material. The natural science module used can be seen in Figure 1. Data analysis was then performed in each class, namely the experimental class and the control class. Meanwhile, the results of the descriptive statistical data analysis are presented in Table 2. From Table 2, the normality and homogeneity test results revealed that the posttest scores of students in the experimental and control classes were not normally distributed, although homogeneous. It was seen from the value of significance in the normality and homogeneity tests of the control class and the experimental class. Therefore, the next test employed the Mann-Whitney U test. Based on the Mann-Whitney U test results, the result was 0.000 (Ho was rejected), signifying a significant difference between the control and experimental classes after learning activities. To be clear, the comparison between the mean test results of students' knowledge aspects can be observed in the following table:

Table 2. Description of Learning Outcome Data on the Knowledge Aspect

Class	Score	N	Mean
Control	Posttest	30	69.83
Experiment	Posttest	30	78.83

In Figure 2, it can be seen that the mean learning outcomes in the knowledge aspect of the experimental class students were better than the control class. Thus, it can be said that learning using scientific-based electronic natural science modules was more effective in improving student learning outcomes in the knowledge aspect compared to conventional learning.

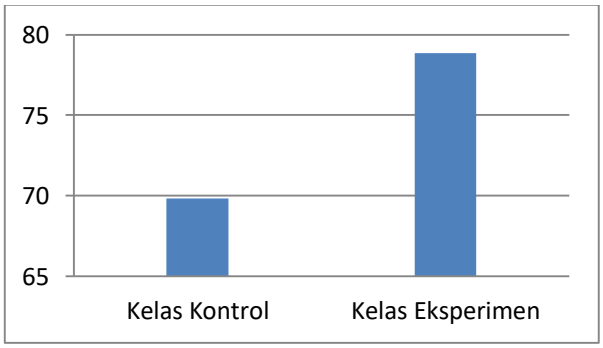

Figure 2. Mean Posttest of Learning Outcomes on Knowledge Aspects in Control and Experiment Classes

The analysis used to determine the effectiveness of the scientific-based electronic science module in the second learning could be seen from the test results whether there was a difference in the posttest score of learning outcomes on aspects of student knowledge between the control class and the experimental class. It was tested with SPSS 20 for windows and started with prerequisite tests: normality test (Kolmogorov-Smirnov), homogeneity test (Levene test), and then the Mann-Whitney U test was carried out because the data were not normally distributed, although homogeneous distribution was met. The analysis results are displayed in Table 3.

Table 3. The Analysis Results of Learning Outcomes on the Knowledge Aspect

Test	Results		Conclusion
Normality (Kolmogorov Smirnov)	Experiment Class	0.000 < 0.005	Not normal
	Control Class	0.000 < 0.005	Not normal
Homogeneity (Levene Statistics)	*Sig.* 0.385 > 0.05		Homogeneous
Mann-Whitney U test	*Sig.* 0.000 < 0.05		There is a significant difference.

This study's results align with the research results (Trapsilo, 2016), which showed that the scientific approach was effective for improving learning outcomes. It is confirmed by Sugeng et al. (2016), asserting that learning using a scientific approach could improve natural science learning outcomes on static fluid material. In addition, research from Arriany (2020) uncovered that the use of online modules effectively increased the mastery of student learning outcomes, as evidenced by using the t-test calculation, which revealed significant differences in student learning outcomes before and after using the module.

Based on observations, in groups that applied the learning using scientific-based electronic natural science modules, there was a tendency for students to participate in learning actively, and activities in the module helped students find facts, concepts, principles, and theories. The findings from this study imply that the use of scientific-based electronic natural science modules in learning activities could provide better learning outcomes on aspects of knowledge in the experimental student group compared to the control student group. It could be seen from the research conducted at SMP Negeri 15 Surakarta that the mean score obtained by students in the group of students taught with the scientific-based electronic natural science module was higher than the mean score obtained by the group of students without the module. It was influenced by the scientific-based electronic natural science module, which emphasized students' activities participating in active learning and guided inquiry activities more to find facts, concepts, principles, and theories.

Furthermore, the scientific-based electronic natural science module trained students to actively participate in class so that learning was not dull and stimulated students to keep learning, even during a pandemic through concept discovery or simulation activities. Meanwhile, the teacher only served as a monitor, facilitator, and evaluator. In addition, with the implementation of this module, students became more critical, as evidenced by actively asking questions when carrying out discussions, and finding their concepts caused students to remember the material taught better.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research results and discussion, it can be concluded that there were differences in learning outcomes in aspects of natural science knowledge between groups of students taught with a scientific-based electronic natural science module and groups of students taught using conventional learning models in class VIII SMP in Surakarta in the academic year of 2020/2021.

The differences could be seen from the mean score of learning outcomes from groups of students taught with a scientific-based electronic natural science module of 78.83, while the mean score of learning outcomes obtained by groups of students taught using conventional learning models was equal to 69.83. Besides, the Mann-Whitney U test result was 0.000. From these results, H0 was rejected, and H1 was accepted. Thus, it can be concluded that there was a significant difference between the control and experimental classes. In other words, the learning outcomes of natural science in the group of students taught with the scientific-based electronic natural science module were better than the group of students taught using the conventional learning model.

Meanwhile, suggestions that can be conveyed regarding this research are that (1) in order for learning with scientific-based electronic natural science modules to run effectively, mentoring needs to be done because independent learning is still foreign. (2) Before using the scientific-based electronic natural science module, the teacher should understand the application of the scientific learning flow and prepare the necessary facilities and infrastructure so that all activities in the module can be followed and implemented effectively. (3) It is recommended that other researchers use the report on the results of this study as a reference for literature in conducting similar research.

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