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The Effectiveness of Electronic Modules on Problem-Solving Oriented Work and Energy Topics to Improve Student Learning Outcomes

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Abstract
Technological developments make the education sector need to present modern learning resources while facilitating students in dealing with problems in the 21st century. Thus, the research aimed to develop an electronic module on the topic of work and energy-oriented to effective problem-solving so that it can be used to improve student learning outcomes. This research is in the form of development research using the ADDIE model. The subjects of this research were 33 students of X MIPA 4 SMA Negeri in Banjarmasin. The data analysis technique used is descriptive quantitative with a learning outcomes test as the research instrument used. The research results explained that the electronic module was declared highly effective with an N-gain score of 0.76. Thus, the electronic module physics on work and energy-oriented problem-solving are feasible to improve student learning outcomes.
Keywords: Effectiveness; Electronic Module; Learning Outcomes; Problem-Solving; Work and Energy

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INTRODUCTION

Learning activities promote interaction between teachers and students by allowing the teacher to act as an actor carrying out teaching activities while the students are the primary topic. Students are expected to be able to collect as much knowledge as possible as a result of learning activities in this activity so that they can be said to have succeeded in achieving the competencies that have been determined. According to Wati et al. (2021), numerous factors influence student learning success, including the learning media used. Science and technology's rapid advancement has resulted in a digitalization revolution in education (Maisaroh et al., 2020; Rahmatullah et al., 2022; Sima et al., 2020). This has resulted in the emergence of alternative learning tools in the form of digitally presented modules, also known as electronic modules (Misbah et al., 2021; Song et al., 2021; Vitrianingsih et al., 2021). Electronic module or *e-modul*e itself is explained by Herawati & Muhtadi (2018), who said that it consists of text, images, or both. Rizaldi et al. (2022) states that electronic modules not bound by time and place make this learning media superior to conventional modules. This makes learning activities more interactive. Students no longer need to carry module books because electronic modules can be stored on their cellphones or laptops, making them ideal for specific topics such as physics.

Physics education, to this far, has only concentrated on completing and memorizing formulas. Students are not guided to understand concepts fundamentally, so they tend to have difficulties when confronted with problems that differ from what is being taught. On the other hand, dominant physics is distinguished by qualitative and quantitative analysis that is directly related to human-life problems (Fahrina et al., 2018). To support the achievement of these goals, a specific ability is needed that enables students to solve everyday problems, one of which is known as problem-solving ability (Mubarok et al., 2022; Rizki et al., 2021; Saputri et al., 2021). According to Polya in (Jainuri, 2014), problem-solving is a person's ability to find a way out of a problem to accomplish certain objectives. However, problem-solving sabilities cannot be learned overnight. As a result, structured electronic courses are ideal for stimulating students' problem-solving abilities. This study adapted the problem-solving steps by (Gaigher et al., 2006) into 6 steps, they are: write down the relevant information, identify the unknown variable, analyse the problem, write down the relevant equation, substitute numerical values and solve the problem, and interpret numerical answers in word.

According to an interview with a physics teacher at one of Banjarmasin's public high schools, students were used to being handed material and formulas without understanding the conceptual relationship between formulas and problems. The teacher also stated that students in class X MIPA 4 who were used as study subjects were still not used to using problem-solving steps in problem-solving, so students frequently only followed the steps demonstrated by the teacher. This led students to struggle when confronted with problems that differed from those exemplified by the teacher. This fact was reinforced by the results of the pre-test that had been carried out, where the results showed the problem-solving ability of students for the step of writing information or data obtained a score of 30,67 in the poor category, identifying unknown variables of 35,15 in the poor category, analyzing problem-solving at 0,00 in the very poor category, writing relevant equations at 8,48 in the very poor category, substituting information and solving problems at 7,58 in the very poor category, and interpretation at 0,00 in the very poor category, making the overall aspect average score only reached 15,73 in the low category.

The learning model used in this study is a cooperative learning model of the *Student Teams Achievement Division* (STAD) type. The advantages of this learning model include increasing student cooperation in formulating problem solutions, fostering a spirit of positive competition, and training the independence of fellow students in solving various problems. Given the STAD-type cooperative model that can stimulate student independence and electronic modules in the form of presenting independent learning material, students are expected to practice solving problems independently through discussions with their group members (Candradewi et al., 2020; Sudarwo, 2017). Furthermore, cooperative learning assessment is done in groups, so each group is expected to have a positive dependency and improve their learning outcomes (Aini et al., 2018).

The findings of this study led to the selection of learning media in the form of problem-solving-oriented electronic modules to improve student learning outcomes. According to research Prasetyaningtyas (2015), the STAD-type cooperative learning model can improve student learning results by 89,7% in the high category. Research by Puspitasari (2019) stated that using electronic modules effectively improves student learning outcomes because of its various advantages. Research by Putri & Usmeldi (2020) shows that using problem-based electronic modules effectively increases student learning outcomes with a completeness of 96,1%.

The use of the STAD cooperative model is novel in comparison to previous research because the model has the advantage of continuously training student independence with the nature of electronic modules that present material independently for students so that students can be more assisted in practicing solving various problems in a module by utilizing the group. The problem-solving approach used in this study (Gaigher et al., 2006) is also uncommon in other studies, so it is anticipated to contribute to the richness of references in the future.

Based on the background described, developing problem-solving-oriented electronic modules to improve student learning outcomes in research is important. The subject of work and energy was chosen because it includes a variety of issues that can be packaged in such an appealing way that students are enthusiastic about participating in the learning that is taking place. The research was entitled "the effectiveness of electronic modules on problem-solving oriented work and energy topics to improve student learning outcomes" to describe the effectiveness of using problem-solving-oriented work and energy-oriented electronic modules in improving student learning outcomes.

METHOD

The research involved *research and development* in creating a result and determining its effectiveness (Sugiyono, 2013). The mixed method allows the data in this research to be presented and explained in depth (Cahyani et al., 2020). The research would create learning media in electronic modules on business and energy to enhance student learning outcomes. The ADDIE model was used for research. Figure 1 depicts the phases of the ADDIE development model.

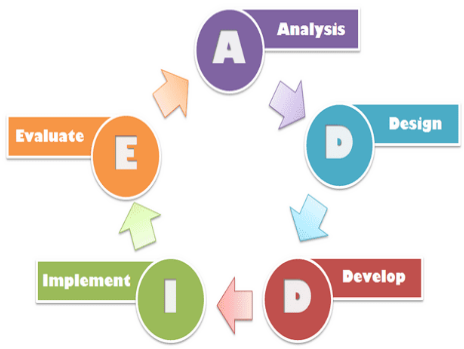

Figure 1 ADDIE stages

The subject of this research was the electronic module. The object of this research was the feasibility of the electronic module on physics on the topic of work and energy-oriented problem-solving to improve student learning outcomes in terms of its effectiveness. The test subjects of this study were 33 students of X MIPA 4 SMAN in Banjarmasin. Learning was carried out in 3 sub-subjects with the STAD-type cooperative learning model. The trial design used was a pre-test post-test (one group pre-test post-test). A comparison was made between the results of the learning outcomes test before and after using the electronic physics module on the topic of work and energy that was developed. The data from the learning achievement exam was then tested using the *N-gain* statistical test, and it was said to be effective if it fell into the moderate category. Table 1 shows the trial design plan that was used.

Table 1 Trial design plan

Initial Test	Treatment	Final Test
O_1	X	O_2

(Sugiyono, 2013)

The problem-solving strategy used in this study adapts the problem-solving steps belonging to (Gaigher et al., 2006), which are divided into six indicators. Table 2 shows the sequence of indicators.

Table 2 Problem-solving indicator

No.	Problem-solving Indicator
1.	Writing relevant information on the problem
2.	Identifying unknown variables
3.	Analyzing problem-solving
4.	Writing the relevant equations
5.	Substituting information for solutions
6.	Interpreting numerical answers into sentences

(Gaigher et al., 2006)

RESULT AND DISCUSSION

Analysis

This stage involved an examination of the student's needs, materials, and characteristics. The researcher interviewed a physics teacher at one of Banjarmasin's high schools to determine the extent of students' problem-solving abilities. As a result, it was discovered that students were only used to memorizing formulas and were rarely given questions that practiced their problem-solving skills, so when problems differed from the examples given by the teacher, students struggled to solve them.

In the pre-test given, the results obtained were also relatively low, where the results showed the problem-solving ability of students for the step of writing information or data obtained a score of 30,67 in the poor category, identifying unknown variables of 35,15 in the poor category, analyzing problem-solving at 0,00 in the very poor category, writing relevant equations at 8,48 in the very poor category, substituting information and solving problems at 7,58 in the very poor category, and interpretation at 0,00 in the very poor category, making the overall aspect average score only reached 15,73 in the low category.

Material analysis entailed identifying learning goals based on the revised 2013 curriculum syllabus so that it was clear that work and energy materials were appropriate for training students' problem-solving abilities.

The average age of students in class X at one of Banjarmasin's high schools were used for a student characteristics analysis. Consequently, the average age of the students in the class where the research would be conducted was more than 11. According to Jean Piaget (Jufri, 2017), at the age of more than 11, students reach the operational-formal stage, where they can develop abstract thinking skills and solve basic problems.

Design

This stage involved the design of the electronic module framework based on the analysis results. This electronic module was created by researchers using Flipbook PDF Professional. It was intended for three meetings, each of which included sub-materials on work and energy and problems to be solved by students using problem-solving steps. The first material included a sub-discussion of the concepts of work and energy, the second discussed the work-energy theorem, and the third discussed the rule of mechanical energy conservation. The front cover, preface, table of contents, instructions for use, concept maps and keywords, material titles and learning objectives, material content and sample questions (simulation), summaries, challenges, self-evaluation, bibliography, and glossary were all included in this electronic module. Figure 2 depicts the look of the electronic module.

Figure 2 Physics electronic module components

Development

At this stage, the module that had been made would be validated by three validators to determine the feasibility of the electronic module. As a result, there were recommendations for changes that must be made before the module could be tested, such as KKO improvements on learning goals and adjusting the font size to save space on the module page. The electronic module was deemed fit for use after improvements were made to these recommendations.

Implementation

At this stage, a tryout was held in class X MIPA 4 at a high school in Banjarmasin with a total of 33 students to determine the effectiveness of the electronic module that had been created using the pre-test and post-test totaling 6 essay questions, with the average result of the two being calculated to obtain the *N-gain score* (Hake, 1998). As stated by Purwanto (2010), exams are administered after students have learned the targeted material to assess the extent of their abilities. Table 3 shows the findings of the calculation of the *N-gain* of the electronic module.

Table 3 *N-Gain* calculation results

***Pre-test* average**	***Post-test* average**	***N-Gain* average**	**Category**
15.73	63.33	0.76	High

Students' cognitive learning results could be assessed using a pre-test and a post-test (Sari et al., 2017). The learning outcomes test had been structured in accordance with the guidelines outlined by Wening (2010); that is, the learning outcomes test in the form of a description must be structured in a concise, concise, and clear manner so that students can easily understand and applied appropriate linguistic rules to avoid erroneous interpretations. The *N-Gain* average score on the efficacy of the electronic module in the learning outcomes test was 0.76, placing it in the high category. Furthermore, student learning outcomes improved from the pre-test, which scored 15.73, to 63.33 during the post-test.

In the pre-test results, where students were not given treatment in the form of using electronic modules, many students were able to identify the variables that were known and asked, although some were still incomplete, affecting their assessment in the first and second stages, namely writing information known and identifying the variables in question. Then, the majority of students had difficulty in the stage of analyzing problem-solving, so they were unable to work on the solution to the problem completely. Students who can analyze problems tend not to compose conclusions or interpret numerical responses into sentences at the end of the solution, causing the solution to become imperfect. With an average of 15.73 out of a possible score of 100.00, students' problem-solving skills remained relatively low.

According to the post-test findings, where students were treated in electronic modules, all students experienced increased problem-solving steps. Most students whose acquisitions achieved the KKM could carry out the problem-solving steps coherently and well, although some students missed certain steps, such as analyzing issues and interpreting. This resulted in incomplete issue solutions and impacted the scores received by students. Students' problem-solving skills improved overall, with a post-test average of 63.33.

The ability to answer problems using sequential and precise problem-solving steps measures students' problem-solving ability. The learning outcomes test results in the shape of pre-test and post-test from points two to six showed improvement. Table 4 showed the outcomes of improving students' problem-solving skills.

Table 4 Comparison of students' problem-solving skills based on pretest and posttest

Problem-solving Indicators	***Pretest***		***Posttest***	
	Mean	**Category**	**Mean**	**Category**
Writing information	30.67	Poor	81.39	Very Good
Variable identification	35.15	Poor	69.70	Good
Analyzing settlement	0.00	Very Poor	4.24	Bad
Writing the relevant equations	8.48	Very Poor	80.91	Very Good
Substituting information	7.58	Very Poor	67.58	Good
Interpretation	0.00	Very Poor	13.64	Bad

Gaigher's steps were used in the study, and they were as follows: write down relevant information on the problem, identify unknown variables, analyze problem-solving, write relevant equations, substitute information to solve problems, and interpret numerical solutions into sentences (Gaigher et al., 2006). The data in Table 4 showed an increase in students' problem-solving skills achievement between the pre-test and post-test. During the pre-test, the stage of writing information or data received an average score of 30.67, which increased to 81.39 during the post-test. The average score in identifying unknown variables was 35.15 during the pre-test and rose to 69.70 during the post-test. During the pre-test stage of analyzing problem-solving, an average score of 0.00 increased to 4.24 during the post-test.

During the pre-test stage of writing relevant equations, an average score of 8.48 increased to 80.91 during the post-test. During the pre-test stage of substituting information to answer problems, an average score of 7.58 increased to 67.58 during the post-test. During the pre-test stage of interpreting numerical responses into sentences, an average score of 0.00 increased to 13.64 during the post-test.

Most students skipped over the phases of analyzing problem-solving and interpreting numerical results into sentences. This was due to students focusing more on high-scoring steps such as writing down information or data, writing down relevant equations, and substituting information to solve problems. This was consistent with the statement of Winarso (2016), which stated that the best potential of learning objectives would be realized only if students were prepared to cope with situations of learning activities.

In addition, this was also due to the weakness of the STAD-type cooperative learning model as stated by Hamdayana in (Nur Syamsu et al., 2019) that this model was very dependent on the cooperation and concern of students for their group mates. The group in this research was heterogeneous, with each member having cognitive differences based on pre-test results as well as gender differences to the greatest extent possible. However, there were some drawbacks, such as students with poor pre-test scores being less active in discussions during learning, despite being encouraged to be more active. Students with better pre-test scores were more active when discussing or asking questions, but less tenacious when teaching their group mates. Indirectly, this phenomenon caused students with lower pre-test scores to become overly reliant on students with higher pre-test scores in answering questions, so they could not solve them independently when they faced the post-test. This was consistent with Damayanti & Tarmedi (2018), who stated that students' active learning should be developed as much as feasible to achieve learning objectives optimally.

Evaluation

At this stage, the evaluation was carried out based on a comparison of the results of the pre-test with the post-test. It could be seen that there was an increase in student learning outcomes. Furthermore, students' problem-solving skills have improved since receiving treatment. This demonstrated that the electronic physics modules developed were effective in enhancing student learning outcomes.

CONCLUSION

Based on the results, it can be stated that the use of the electronic module physics on the topic of work and energy-oriented problem-solving to improve student learning outcomes can be applied in the learning process because it achieved an effectiveness score of 0,76 in the high category and can improve students' problem-solving skills. However, there are still shortcomings in minor improvements in certain problem-solving steps. The study's findings were presented as an electronic physics module, claimed to be capable of improving student learning outcomes on work and energy. The next researcher is expected to be able to develop research excellence while also improving its weaknesses in other chosen subjects.

REFERENCES

Aini, N., Zainuddin, Z., & Mahardika, A. I. (2018). Pengembangan materi ajar ipa menggunakan model pembelajaran kooperatif berorientasi lingkungan lahan basah. *Berkala Ilmiah Pendidikan Fisika*, *6*(2), 264. https://doi.org/10.20527/bipf.v6i2.4919

Cahyani, A. E. M., Mayasari, T., & Sasono, M. (2020). Efektivitas e-modul project based learning berintegrasi stem terhadap kreativitas siswa smk. *Jurnal Ilmiah Pendidikan Fisika*, *4*(1), 15. https://doi.org/10.20527/jipf.v4i1.1774

Candradewi, W. C., Dharsana, I. K., & Tegeh, I. M. (2020). Student teams achievement division technique and group investigation technique through lesson study enhancing students learning outcomes. *International Journal of Elementary Education*, *4*(3), 310-320.

Damayanti, A., & Tarmedi, E. (2018). Implementing cooperative script type of cooperative learning model to improve students' activeness in learning social studies. *International Journal Pedagogy of Social Studies*, *3*(1), 129–136.

Fahrina, F., Jamal, A., & M, A. S. (2018). Meningkatkan kemampuan analisis sintesis siswa kelas x mia 6 sma negeri 2 banjarmasin melalui model pengajaran langsung dengan metode problem solving. *Berkala Ilmiah Pendidikan Fisika*, *6*(1), 98. https://doi.org/10.20527/bipf.v6i1.3897

Gaigher, E., Rogan, J. M., & Braun, M. W. H. (2006). The effect of a structured problem solving strategy on performance in physics in disadvantaged south african schools.

African Journal of Research in Mathematics, Science and Technology Education, *10*(2), 15–26. https://doi.org/10.1080/10288457.2006.10740601

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1), 64–74. https://doi.org/10.1119/1.18809

Herawati, N. S., & Muhtadi, A. (2018). Pengembangan modul elektronik (e-modul) interaktif pada mata pelajaran Kimia kelas XI SMA. *Jurnal Inovasi Teknologi Pendidikan*, *5*(2), 180–191. https://doi.org/10.21831/jitp.v5i2.15424

Jainuri, M. (2014). Kemampuan pemecahan masalah matematika. *Acamedia*, *1*(1), 1–8.

Jufri, W. (2017). *Belajar dan pembelajaran sains*. Pustaka Reka Cipta.

Maisaroh, M., Mayasari, T., & Sasono, M. (2020). Pengembangan modul elektronik berbasis real life learning untuk meningkatkan kemampuan analisis siswa smk. *Jurnal Ilmiah Pendidikan Fisika*, *4*(1), 33. https://doi.org/10.20527/jipf.v4i1.1776

Misbah, M., Khairunnisa, Y., Amrita, P. D., Dewantara, D., Mahtari, S., Syahidi, K., ... & Deta, U. A. (2021). The effectiveness of introduction to nuclear physics e-module as a teaching material during covid-19 pandemic. *Journal of Physics: Conference Series*, 1760(1), 012052. IOP Publishing.

Mubarok, A. Z. Z., Ismet, I., & Kistiono, K. (2022). Pengembangan modul elektronik fisika untuk meningkatkan kemampuan berpikir kreatif peserta didik pada materi hukum newton. *Jurnal Ilmiah Pendidikan Fisika*, *6*(1), 87–98.

Nur Syamsu, F., Rahmawati, I., & Suyitno, S. (2019). Keefektifan model pembelajaran stad terhadap hasil belajar matematika materi bangun ruang. *International Journal of Elementary Education*, *3*(3), 344. https://doi.org/10.23887/ijee.v3i3.19450

Prasetyaningtyas, S. (2015). Penerapan model pembelajaran koperatif stad untuk meningkatkan keaktifan dan prestasi belajar ipa pada materi pewarisan sifat siswa kelas ix smp negeri 1 …. *Prosiding SNPS (Seminar Nasional …*, *November*, 430–442. https://jurnal.fkip.uns.ac.id/index.php/snps/article/view/8310

Purwanto, M. N. (2010). *Prinsip-prinsip dan Teknik Evaluasi Pengajaran*.

Puspitasari, A. D. (2019). Penerapan media pembelajaran fisika menggunakan modul cetak dan modul elektronik pada siswa sma. *Jurnal Pendidikan Fisika*, *7*(1), 17–25.

Putri, H. E., & Usmeldi, U. (2020). The development of e-modules problem based learning using goole classroom for basic electricity and electronics at vocational school. *Cyberspace: Jurnal Pendidikan Teknologi Informasi*, *4*(2), 84. https://doi.org/10.22373/cj.v4i2.7861

Rahmatullah, A. S., Mulyasa, E., Syahrani, S., Pongpalilu, F., & Putri, R. E. (2022). Digital era 4.0: The contribution to education and student psychology. *Linguistics and Culture Review*, *6*(S3), 89-107.

Rizaldi, W. R., Sudirman, Pasaribu, A., & Saparini. (2022). Pengembangan modul elektronik alat-alat optik berbasis stem menggunakan aplikasi flip pdf professional. *Jurnal Ilmiah Pendidikan Fisika*, *6*(2), 360–367.

Rizki, M., Wati, M., & Misbah, M. (2021). Electronic thermodynamics teaching materials based on authentic learning to practice students' problem-solving skills: Aspects of validity. *Journal of Physics:*

Conference Series, 2104(1), 012018. IOP Publishing.

Saputri, S. R., Wati, M., & Misbah, M. (2021). Simple harmonic motion electronic teaching materials based on authentic learning to train students' problem-solving skills: aspects of validity. *Journal of Physics: Conference Series*, 2126(1), 012016. IOP Publishing.

Sari, N., Annur, S., & Mahardika, A. I. (2017). Pengembangan lks pembelajaran fisika dengan menggunakan model clis (children learning in science) di smp 1 muhammadiyah banjarmasin. *Berkala Ilmiah Pendidikan Fisika*, *5*(2), 159. https://doi.org/10.20527/bipf.v5i2.2872

Sima, V., Gheorghe, I. G., Subić, J., & Nancu, D. (2020). Influences of the industry 4.0 revolution on the human capital development and consumer behavior: A systematic review. *Sustainability*, *12*(10), 4035.

Song, S. J., Tan, K. H., & Awang, M. M. (2021). Generic digital equity model in education: Mobile-assisted personalized learning (MAPL) through e-modules. *Sustainability*, *13*(19), 11115.

Sudarwo, P. R. (2017). The effect of STAD cooperative learning and expository methods and learning independence on educational statistics learning outcomes. *Journal of Education and Practice*, *8*(35), 130-140.

Sugiyono, S. (2013). *Metode penelitian pendidikan*. Alfabeta.

Vitrianingsih, D., Aulianingsih, I., & Yuliani, H. (2021). Analisis kebutuhan pengembangan modul elektronik (e-module) ipa terintegrasi islam. *Jurnal Ilmiah Pendidikan Fisika*, *5*(1), 27. https://doi.org/10.20527/jipf.v5i1.2525

Wati, L., Rahimah, R., Nengsih, E. W., & Mardaya, M. (2021). Media pembelajaran majalah fisika terintegrasi nilai keislaman. *Jurnal Ilmiah Pendidikan Fisika*, *5*(2), 192. https://doi.org/10.20527/jipf.v5i2.2731

Wening, S. (2010). *Bahan perkuliahan evaluasi belajar mengajar*.

Winarso, W. (2016). Assessing the readiness of student. *Jurnal Pencerahan*, *10*(2), 81–94.