JPPIPA 9(8) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of CORE-based Electronic-modules to Improve Students' Problem-Solving Skills

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Received: February 13, 2023
Revised: July 20, 2023
Accepted: August 25, 2023
Published: August 31, 2023

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DOI: 10.29303/jppipa.v9i8.3172

Abstract: Students must be trained and develop problem-solving skills as part of 21st-century skills. The study aims to determine the feasibility and implementation of learning CORE-based Electronic-modules and the improvement of students' problem-solving skills on impulse-momentum material. The research method used is Research and Development with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The instrument used is a validation sheet (expert of material and media and teachers), student worksheets, and tests. The results show CORE-based Electronic-modules after validation an average feasibility of 80% and the implementation of learning activities using CORE-based Electronic-modules an average of 84% including in the very good category. Student worksheets with an implementation percentage of 81% with effective criteria Enhancing students' problem-solving skills of 0.64 with moderate interpretation. The results of hypothesis testing using a paired obtained a t_{count} of 31.00 > t_{table} of 2.04. The results show there are differences in problem-solving skills after the implementation of CORE-based electronic modules. The CORE-based electronic modules are feasible to use in the classroom learning process and can improve students' problem-solving skills on impulse-momentum material.

Keywords: CORE; Electronic-modules; Impulse Momentum; Problem-Solving Skills

Introduction

The purpose of education in Indonesia, according to Mulyaningsih et al. (2022) expects an increase in skills in terms of student competence to be more independence. The learning process in the classroom is expected to hone and improve aspects of students' competitive skills (Ritonga et al., 2022). According to Prahani et al. (2022) the skills that must be improved in learning physics in the 2013 curriculum are problem-solving in process and results.

Problem-solving is a fundamental must-have in the research and learning process of physics (Heller, 2010). The definition of problem-solving by Pal & Rinki (2022) and Maknun (2020) is a fundamental skill in studying physics, a critical thinking process that can construct conditions with complex concepts. Learning physics in the classroom invites students to visualize physics to solve a problem through a conceptual investigation frame of mind from several theories to understand the correlation between physics concepts and existing problems (Ziatdinov & Valles, 2022).

Students demanded can use the knowledge and initial concepts they have learned to find solutions to the problems given (Prihartanti et al., 2017). However, in reality, students' problem-solving skills in physics material are still in the low category. This can be seen in the research of Maulina & Wahyuni (2022); Shoffa (2022); Riska et al. (2022) percentage of correct answers to questions using problem-solving skills indicators resulted in a low score. Because of due to students being less able to construct thoughts and concepts they had when solving problems given by the teacher. The problem-solving skills of students in physics subjects have 15% in the medium category, and 85% of students fall into the category less in indicators of solving physics problems (Ramadayanty et al., 2021).

A preliminary study conducted at a school in the city of Bandung in the form of a problem-solving skill test by Yuliati et al. (2018) showed that student problem-solving skills were in a low category, namely obtaining

How to Cite:
Nur D.S.Y., Fitri, A., Latifatusadiah, T., Dewi, S.M., & Febriansyah, F. (2023). The Effect of the Flipped Classroom Model on Self Efficacy Student in Limited Face Learning. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6278–6283. https://doi.org/10.29303/jppipa.v9i8.4340

an average of 23% overall. The highest average score achieved by students is found in the mathematical approach indicator of 24%. The lowest average value can be seen in the physics concept application indicator, which is 13%. The low problem-solving is caused by the lack of physics learning in problem-solving (Simanjuntak et al., 2021). Another factor is the lack of use of learning tools that visualize physics learning (Setyarini et al., 2021). Based on the results of observations in classroom learning at a school in the city of Bandung, the learning process only uses conventional learning tools in textbooks and printed modules that are limited in quantity and contain only writings and mathematical formulas. The use of learning tools in the form of modules and learning media in the classroom is classified as lacking. Teachers only occasionally use media in the form of power points and use learning resources from the internet. Learning tools used in class have not trained directed students' problem-solving.

Teachers as learners must innovate in developing attractive learning media (Septiantoro & Widaningsih, 2022). The innovation is by developing learning tools and then adapting them to current developments (Kukulska-hulme et al., 2022). According to Maha et al. (2022); Arifuddin et al. (2021) and Afriyanti et al. (2021), the module is a supporting learning tool that allows students to implement it in physics learning. An electronic module is an electronic version of a printed and computer-readable module designed using the required software (Syarlisjiswan & Wahyuningsih, 2021). Expansion of print modules into electronic modules is one way to improve students' solving skills (Fitri et al., 2019).

The development of e-modules needs to use approaches, methods, or models to be more focused and structured because of the steps in learning (Setyarini et al., 2021). Based on previous research, the development of e-modules can improve students' problem-solving skills (Utami et al., 2018; Ramadayanty et al., 2021; Agustini et al., 2021).

The learning model that will be applied is the CORE (Connecting, Organizing, Reflecting, Extending). Learning using the CORE model itself can connect the knowledge possessed by students with the information received so that it can be used as a benchmark for the effectiveness of problem-solving (Avianti et al., 2018). Development of learning devices in the form of print modules to be developed into electronic modules based on learning models (e-modules CORE-based. The selection of learning materials used in the CORE e-module is impulse momentum material. The choice of this material is based on the concept of abstract and is found in everyday life. The concept of impulse-momentum is a physical concept related to vector quantities mass of an object and its velocity (Setyarini et al., 2021).

The developed e-module can be accessed by students via smartphones anywhere and anytime. The novelty of this research is that the E-module contained material on impulse-momentum, animations that can be operated by the user, video visualization of theory and problems, animations in everyday life, and attractive questions in the form of quizzes in Android or IOS. Students accessed easily without using the internet quota because the application form can be accessed offline (Azizah, 2020). According to Putri & Usmeldi (2020), the developed E-module must also comply with the criteria for the facilities and infrastructure standard. E-module is complete, relevant, and functioning well to support the learning process. Based on the problems above, it is necessary to develop learning tools in the form of learning modules that can improve students' problem-solving skills and motivation in learning physics.

Method

The method used in this research is R & D (Research and Development) with the ADDIE design from Dick and Carry (1996). ADDIE design has several stages: analysis, design, development, implementation, and evaluation. The sample in this study consisted of 31 students of class X MIPA 3, consisting of 18 females and 13 males. The sample has intelligence heterogenic.

The instruments used in this study included media validation sheets and test of problem-solving skills test questions. Media validation was carried out by three validators, namely material experts, media experts, and physics teachers. The validation sheet consists of 12 statements for content and presentation appropriateness tests and 10 for language appropriateness tests. The media validation sheet is arranged based on several aspects, namely aspects of material presentation, aspects of the media display, and media aspects of learning. Material validation sheets are arranged based on curriculum, material, and language aspects. While the field expert validation sheet is prepared based on a combination of media and material expert validation sheets consisting of media, curriculum, material, content, and language aspects. Feasibility instruments are compiled and modified based on research (Romadhona, 2021; Purnama, 2021; Susilawati, 2021).

Learning applies the steps of the CORE model. The learning stage is Connecting. Organizing. Reflecting and Extending. The implementation of learning using the CORE-based e-module was observed by observers. The observer uses the AABTLT with the SAS assessment instrument (Rochman et al., 2018). The AABTLT with

SAS assessment instrument that consists of 19 quiz questions to assess application at each meeting.

Problem-solving test indicators are useful descriptions, physics approaches, specific physics applications, precise mathematical procedures, and logical progress (Doctor & Heller, 2009). The test consists of fifteen questions of the type of description accompanied by a rubric for assessment. These measurements are carried out through pretest-posttest activities, namely tests before and after learning activities using CORE-based e-modules.

Research data on the feasibility of CORE-based e-modules and problem-solving skills were processed and analyzed. The data analysis technique used to analyze the media validation sheet is analyzed concerning the media eligibility criteria in Table 1.

Table 1. Conversion of data to determine the feasibility of the Media (Simarmata et al., 2021)

Percentage (%)	Eligibility Level
0.00 49.99	Very bad/not attractive/invalid
50.00–59.99	Less good/less attractive/less valid
60.00–79.99	Good/attractive/valid
80.00–100.00	Very good/very interesting/very valid

Data on the results of the implementation of the CORE-based e-module. The AABTLT with SAS assessment sheet was calculated and presented. The processing results were then analyzed based on the criteria in Table 2.

Table 2. Learning implementation criteria (Rochman et al., 2018)

Score	Interpretation
< 55	Ineffective
55 - 70	Less effective
71 - 85	Effective
> 85	Very effective

The test results of students' problem-solving skills were processed using the Hake formula and interpreted according to Hake's criteria in Table 3.

Table 3. Category of N-Gain values (Hake, 1998)

N-Gain Index	Interpretation
> 0.70	High
0.30-0.70	Medium
< 0.30	Low

Result and Discussion

The development of the CORE-based e-module is based on the ADDIE design. The ADDIE design consists of analysis, design, development, implementation, and evaluation. The stage analysis is defining, identifying, and analyzing problems in learning in the field. The data was obtained from interviews with physics subject teachers, learning observation data, student questionnaire data regarding classroom learning, and initial data on students' problem-solving skills in the impulse-momentum (Pramana et al., 2020). The results obtained in applying learning in the classroom, teachers have used a conventional module in the form of a printed module in the learning process. The use of media during the learning process is a whiteboard, and in the form of a PowerPoint from the teacher, effective and efficient media is needed.

The lack of use of learning media in lessons resulted in a lack of understanding of students in physics learning materials. In the era of development, students are also required to have good problem-solving skills as one of the demands of skills in the 21st century (Shobrina et al., 2020). However, in learning activities, students' problem-solving skills tend to be less trained in the learning process solution is needed to overcome these problems, namely by using learning media can train and improve students' problem-solving skills through technological developments.

Furthermore, to find out data on students' problem-solving skills, a question test was conducted using the problem-solving skill question instrument (Ariani, 2020). The result is that students' problem-solving skills are still low. The second stage designs, this stage the design of learning devices in the form of electronic module is carried out so that they can be effectively used in the classroom (Hadiyanti et al., 2021). The design of learning devices in the form of e-modules starts with making storyboards and flowcharts related to the flow that will be taken in making e-modules (Suhartati, 2021). The use of smart app creators in making applications can make it easier to add exciting animations about the material, such as impulse-momentum.

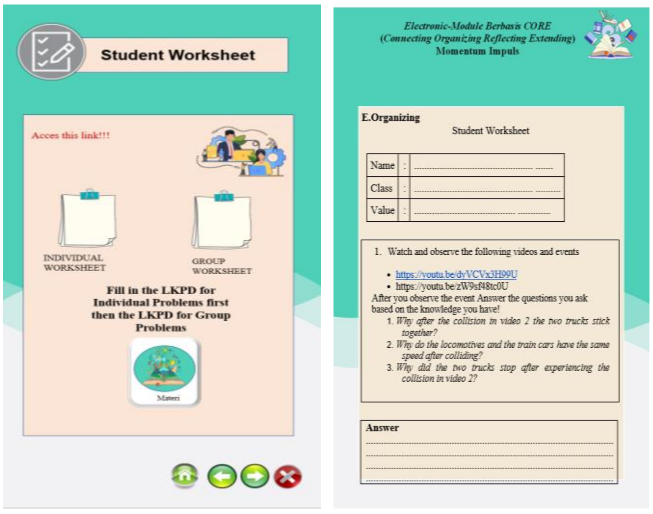

Figure 1. Examples of CORE-based e-module display on the smart app's creator application

The third stage is development, which refers to the design that has been made and the validation process by a team of experts (Kurniawan & Syafriani, 2021). The E-module starts with making titles, description materials, making applications for editing. Editing is done by editing the e-module that has been designed. The following is the appearance of the e-module on the smart apps creator (Pawani et al., 2022).

In this smart app's creator, the e-module is enhanced in terms of content and content by adding visualization of material in the form of videos, animations, links, and images that have been adjusted to the fundamental competencies of the e-module (Pebriani et al., 2022). In addition, smart apps can make a menu of hyperlinks to switch views from one menu to the next (Muzakkir et al., 2022). Next is the validation process by a team of experts to find out whether the e-module developed is feasible or not to be used as a learning medium (Sofyan et al., 2019).

Table 4. Assessment by media expert validators

No	Aspect Validation	Percentage (%)	Category
1.	Media presentation	85	Very eligible
2.	Media display	72	Eligible
3.	Media for learning	80	Eligible
Average		79	Eligible

Based on the results of the feasibility assessment by media expert validators obtained a validation percentage of 79% and entered into the very feasible category. The lowest percentage value is in the media display aspect, while the highest is in the media presentation aspect. This assessment is by the research conducted by Roy et al. (2022) value given by the media expert validator is 79%, and the developed media is said to be feasible to be implemented in learning.

Table 5. Assessment by expert validator material

No	Aspect validation	Percentage (%)	Category
1.	Curriculum	80	Eligible
2.	Material	70	Eligible
3.	Language	79	Eligible
Average		76	Eligible

Based on the results of the feasibility assessment by the material expert validator, the validation percentage is 76% and is included in the very feasible category. The lowest percentage value is in the material, while the highest is in the curriculum aspect. This is to the research conducted (Dayani et al., 2021) the value given by the material expert validator is 76% and the material used in the e-module is said to be feasible to be implemented in learning.

Table 6. Assessment by field expert validator

No	Aspect validation	Percentage (%)	Category
1.	Media	93	Very eligible
2.	Presentation	83	Eligible
3	Curriculum	83	Eligible
4	Content	88	Very eligible
5	Language	93	Very eligible
Average		88	Very eligible

Based on the results of the feasibility assessment by field expert validators, the validation percentage is 88% and falls into the very feasible category. The lowest percentage value is in the material, while the highest is in the curriculum aspect. This is in accordance with the research conducted (Septiani et al., 2022) the value given by the material expert validator is 88% so that the overall e-module developed is feasible to be implemented in learning.

Table 7. Total feasibility test assessment score by expert validators

No	Validation Results	Percentage (%)	Category
1.	Material expert validation	79	Eligible
2.	Media expert validation	76	Eligible
3.	Physics teacher validation	87	Very eligible
Average		81	Eligible

Overall e- CORE-based modules can be categorized as suitable for use as a medium in the learning process. The highest percentage was obtained in the validation assessment of field experts, namely physics teachers a score of 87% in the very feasible category. This is because the validation instrument presented to the field validator contains a summary of each material and media validation. According to Agustini et al., (2021); Junitasari et al., (2021); Shobrina et al., (2020) Sari & Karyati, (2020); Syarlisjiswan & Wahyuningsih, (2021) in their research revealed that the media that had been tested for feasibility with the percentage category Eligible could be implemented in learning. Research conducted by Aslam et al. (2021) that the results of their research indicate that the development of e-modules can improve learning outcomes and student motivation with the lowest percentage in the validation of learning media experts of 76% in the medium category.

The qualitative data were obtained from suggestions and criticisms from expert validators, so it can be concluded that the CORE-based e-module is feasible to be implemented in the classroom with the recommendation that it needs to be improved (Suartama et al., 2022). Based on the suggestions and criticisms given by the validator, the following are the results of the improvements made by the researcher.

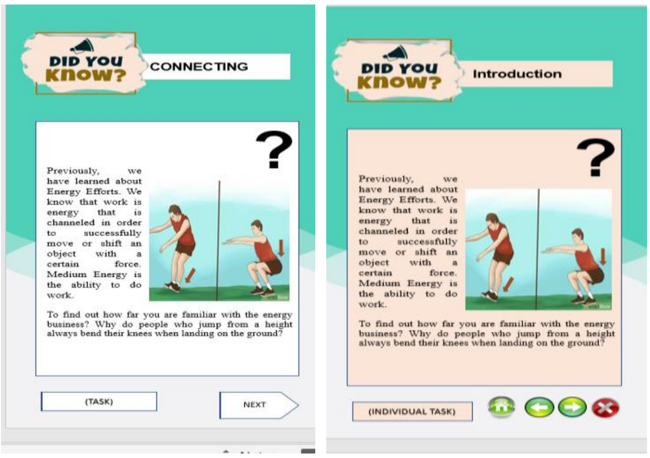

Figure 2. E-module CORE before and after revision

The fourth stage is implementing, in the implementation stage, namely implementing Electronic-modules that have been validated and revised according to suggestions and criticisms from the validator. In this implementation process, CORE-based e-modules are used by students. Furthermore, the use of the CORE-based e-module was then analyzed to determine the implementation of learning using the AABTLT with SAS

Table 8. Percentage of implementation of CORE stages

No	CORE stages	Meeting (%) 1	2	3	Average (%)	Interpretation
1	*Connecting*	79	82	86	82	Effective
2	*Organizing*	78	80	85	81	Effective
3	*Reflecting*	77	79	84	80	Effective
4	*Extending*'	76	78	83	79	Effective

The stages of learning CORE have increased in percentage of completion. The highest achievement percentage of implementation is at the connecting stage an average of 82%. In the connecting stage, students tend to be able to connect problems found in everyday life related to physics concepts. According to Prastika et al. (2021), the connecting stage allows students to review the material they have learned so that they can connect physics concepts with problems in everyday life. The lowest stage is the extending stage with an average of 79%. Students in this stage lack the focus of students in learning. Besides, influenced by the lack of student's ability to formulate solutions to the problems presented (Nasriyanti et al., 2021).

Table 9. Average of learning implementation overall

Meeting	Percentage Implementation (%)	Category
1	77%	Effective
2	80%	Effective
3	85%	Very effective
Average	81%	Effective

The average learning implementation using e-CORE-based modules with the help of the AABTLT with SAS is 81%. The percentage gain can be said that the learning process is effective. The highest implementation was at the third meeting, with the collision sub-material of 85%. The lowest is found at the first meeting with the Impulse and momentum sub-materials. The last meeting is a high percentage value among several other meetings. At the third meeting, the students were familiar with learning using e-modules CORE-based. At this meeting, students have adapted and have been carried out so that the results at the third meeting tend to be high. These results are the same as those of research conducted by Rahmatina et al. (2020) regarding electronic modules in learning with the CORE approach. The achievement of learning implementation at the last meeting had the highest percentage at the first meeting. It had the lowest among other meetings. Students' skills influence results. Students hard-capture information explained by the teacher during learning activities (Rochman, 2018; Khoiriroh & Shofiyah, 2019). Improve student's problem-solving skills for each indicator can be seen in Table 10.

Table 10. N-Gain analysis of each indicator of problem-solving skills

No	Indicator	Pretest	Posttest	Value N-gain	Interpretation
1	Useful description	62	86	0.64	Medium
2	Physics approach	49	81	0.62	Medium
3	Specific application of physics	46	74	0.51	Medium
4	Mathematical procedures	44	78	0.61	Medium
5	Logical progression	48	85	0.71	High
Average		50	81	0.62	Medium

Improvement of students' problem-solving skills is also analysis carried out N-gain each indicator of problem-solving skills (Gunawan et al., 2020). The lowest increase was found in specific physics application indicators. The increased low was by internal factors from students who were not accustomed to applying specific physics concepts in physics learning. Students have difficulty applying the physics concepts that are understood in problem-solving. The student has difficulty understanding the physics equations that are presented. It has an impact on the low ability to solve the problems presented (Mahardini, 2020; Scheel et al., 2022).

Hypothesis testing uses paired t-test analysis with a significance value of 5%. The calculation results show that tcount is greater than ttable (31.0 > 2.04). Thus, Ho is rejected, and Ha is accepted. It can be concluded that there are significant differences in students' problem-solving abilities after using e-CORE-based modules (Li & Zhang, 2022; Zhi et al., 2022). This is similar to the research of Nurul Fatikhakh et al., (2018) who suggest the use of teaching materials in the form of interactive media with the CORE model approach can help improve students' higher-order thinking skills (HOTS). Furthermore, Rahmatina et al. (2020) and Sinaga & Rufaidah (2022) explain that the CORE-based module helps improve student learning outcomes significantly.

The fifth stage is evaluation, that stage is carried out to see the suitability of the development of CORE-based e-modules to improve problem-solving skills and the quality of the media according to suggestions from the validator (Bulkani et al., 2022; Maison & Wahyuni, 2021).

The developed e-module has its characteristics and produces output in the form of an application on a smartphone that is compiled using the smart apps creator application. The developed CORE-based e-module supports interactive, effective, and efficient physics learning. According to (Fitriah et al., 2021) a CORE-based e-module must be equipped with visualization of impulse-momentum material in the form of animations, pictures, and sketches related to the application of the impulse-momentum concept in everyday life. By the objectives of the CORE model, students are directed to investigate the concepts of everyday life through the presented worksheets. Students are expected to be able to analyze the phenomena that occur and have skills in solving problems found in everyday life as the final result of learning (Laia & Harefa, 2021). The quality of the developed CORE-based e-module based on the validation carried out by material experts, media experts, and field experts resulted in the CORE-based e-module meeting the eligible criteria.

This research also has limitations, including the size of the resulting application being too large and not compatible with Android versions with Jelly Bean OS and below. It is necessary to adjust the content can be compatible with several older versions of Android. In addition, the unstable internet network conditions in filling out worksheets on CORE-based e-modules result in students taking a long time to work on them. The condition of the internet network in Indonesia is one of the inhibiting factors in the learning process, this is caused by lack of the stability of the available network so that it takes a long time in the learning process in the classroom (Syafrayani et al., 2022; Prasetyanto et al., 2022; Umayah et al., 2019).

Conclusion

The CORE-based electronic module on the momentum impulse is declared valid by media experts. The results of the validation show that the CORE-based electronic module is feasible to use in learning. The implementation of learning using CORE-based electronic modules is considered effective. Improvement of students' problem-solving skills is included in the moderate category. Thus, the CORE-based electronic module can be applied to other materials in physics learning. In addition, this module is expected to improve other 21st-century skills.

Acknowledgments
The author would like to thank the civitas of SMA PGRI 3 Kota Bandung who has helped during the research.

Author Contribution
Adam Malik: writing-original draft preparation, result, discussion, methodology, conclusion; Muhammad Algi Al-Hanafi: collecting and processing data; Muhammad Minan Chusni: analysis and review; Andi Rohendi Nugraha: proofreading and editing.

Funding
This research is self-funded.

Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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