

# Development of Basic Electronics E-Modules Integrated with Problem Solving Models to Improve Students' Mastery of Concepts and Creative Thinking

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Received: October 23, 2023

Revised: December 17, 2023

Accepted: December 25, 2023

Published: December 31, 2023

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DOI: [10.29303/jppipa.v9iSpecialIssue.5880](https://doi.org/10.29303/jppipa.v9iSpecialIssue.5880)

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**Abstract:** In the 21st century, the Indonesian nation faces many global challenges. These demands include students having to have verbal and written communication skills, teamwork, creativity, research and problem solving skills to be able to compete in the future. To emphasize understanding and develop creative thinking, students need to be facilitated with tools that support learning. One of them is e-module. This research aims to determine the validity of basic electronics e-modules which are integrated with problem solving models to improve students' mastery of concepts and creative thinking. This research is Research and Development (R&D). Development is carried out by referring to the ADDIE model. The instrument used in this research is a basic electronics e-module validation sheet. The validity become evaluated the use of Aiken's V scale. Based on the results of basic electronics e-module validation data analysis, the average e-module validation value was 0.87. It can be concluded that the basic electronics e-module which is integrated with a problem solving model to improve students' mastery of concepts and creative thinking is declared valid and suitable for use.

**Keywords:** Basic electronics; Creative thinking; E-module; Mastery of concepts; Problem solving models

## Introduction

In the 21st century, the Indonesian nation faces many global challenges. These demands include that students must have verbal and written communication skills, teamwork, creativity, research skills and problem solving to be able to compete in the future. Apart from that, students also use their abilities to solve the problems they face, organize and express, analyze to solve problems (Karim, 2017). The 21st century skills are the answer to these global challenges in the field of education. The 21st century skill in question is that everyone masters the 4C skills (Nazifah & Asrizal, 2022). Fierce competition in the 21st century demands that humans have quality resources (Asrizal & Utami, 2021).

A person needs to develop a wide range of abilities to succeed in 21st-century life. Because of this, education ought to be able to assist students in developing the various skills necessary for success in life. To produce quality, globally competitive human resources, 21st-century learning is crucial (Mufit et al., 2020). Students' ability to create solutions to problems is inseparable from the ability to think critically and creatively. Critical and creative thinking skills are higher-order thinking skills and skills needed in 21st-century learning (Sukma et al., 2023).

Creative thinking is one of the 21st century skills that every student must have. In every learning activity, it must be able to facilitate students to be able to express many ideas in the activities carried out by students,

### How to Cite:

Triani, F., & Asrizal, A. (2023). Development of Basic Electronics E-Modules Integrated with Problem Solving Models to Improve Students' Mastery of Concepts and Creative Thinking. *Jurnal Penelitian Pendidikan IPA*, 9(SpecialIssue), 88-94. <https://doi.org/10.29303/jppipa.v9iSpecialIssue.5880>

whether in the form of questions or answers (Purwati & Alberida, 2022). Creative thinking is the ability to answer problems based on existing data/information with various alternative answers. The answers given demonstrate originality, flexibility, fluency, and elaboration (Suryana et al., 2021). The creative thinking procedure can aid college students' creative thinking ability. College students can be greater assured in growing their potential and think creatively. Creative thinking is the capacity possessed to reply to troubles primarily based totally on current information with diverse styles of answers (Hufri & Triani, 2022).

Creative thinking skills can be improved through learning activities on campus by providing problems or problems that students must solve (Yazar Soyadı, 2015). Creative thinking skills are needed by students to solve problems. Especially considering the challenges of 21st century education which require the birth of a superior generation (van Laar et al., 2020). With varied methods, students are required to be able to understand several varied methods and strategies in order to create something new, thereby developing their thinking abilities. The creative thinking process can support students' abilities in the problem solving process. Students will be more confident in developing their potential (Miyatun et al., 2021).

Another most important skill that must be developed through learning activities is problem-solving ability because it helps students solve problems. Additionally, finding a set of rules that can be combined to address new circumstances is a problem-solving process. Students' ability to solve problems is critical to their future success. Within certain limits, the subjects and fields of study taught can develop problem solving skills (Rahman, 2019).

One of the mandatory courses in the Physics Department of FMIPA UNP is Basic Electronics. This course is a theoretical and practical course that emphasizes students' understanding of basic electronic components and electronic circuits. To support the learning process, e-modules are needed that can develop student abilities. The 21st century requires students to have 4C skills, namely critical thinking skills, creative, communication and creating innovation in learning. In the 21st century, abilities that really need to be developed are 4C skills, one of which is creative thinking (Rudianto et al., 2022). But in fact the hope of 21st century learning is still far from what was expected. So it's the 21st century learning really requires innovation, especially the teaching materials used (Husniyah & Ramli, 2023).

Based on research results (Hufri et al, 2023), the learning outcomes obtained by students in basic electronics courses are still not as expected, from the distribution of basic electronics grades over the last three

years with a sample size of 108 students in 2019, and in 2020 as many as 63 people and in 2021 there will be 97 people, which can be seen in the graph in Figure 1.

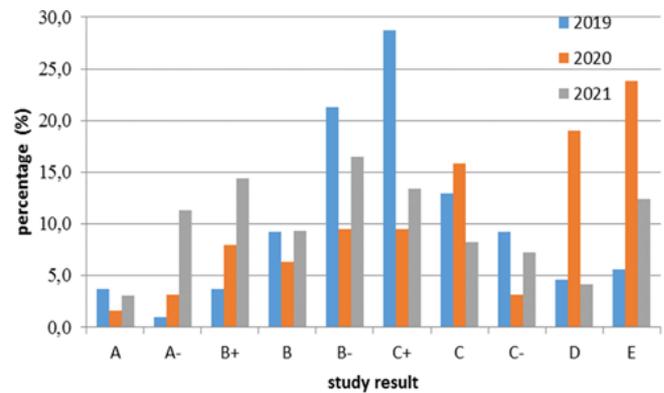


Figure 1. Distribution of basic electronics values 1 (Hufri et al, 2023)

In Figure 1, it can be seen that student learning outcomes in terms of students' ability to master concepts in basic electronics courses are still low. In the distribution of grades with the highest percentage, they are grades B- and C+. Obtaining low learning outcomes shows an indication of low mastery of concepts and student learning activities.

To support the learning process, e-modules are needed that can develop student abilities. In the 21st century, the abilities that really need to be developed are the 4C skills, one of which is creativity. Creative thinking is the ability to think that an individual has and can direct the individual to thoughts that are full of creativity, so that he is able to create something new and unique work that is different from previous works (Tengku, 2022). Students' creative thinking abilities can be developed with e-modules and can evaluate which parts of creative thinking indicators have not been mastered well. The use of e-modules is expected to make it easier for students to know and develop creative thinking skills and mastery of concepts in basic electronics courses so that they can increase student competence in the material and also optimize creative thinking abilities (Musaidah et al., 2022). The ability to think creatively is one of the core elements of the learning process. Creative thinking is a skill that begins with being sensitive to a situation and seeing or identifying the situation as a problem to be solved, so the ability to think creatively is very important for all students (Sari et al., 2023).

Basic electronics material facilitates many indicators of creative thinking, such as analyzing circuits, designing/making circuits, asking students to generate ideas for solving problems or answers to various questions, analyzing images and labeling their parts, asking students to provide detailed explanations.

Detailed, predicting relationships and linkages. These statements are part of the indicator of the four aspects of creative thinking (fluency, flexibility, originality, and elaboration) (Nurzulifa & Dwijanto, 2021).

Based on the analysis of two basic electronics modules used in lectures, the percentage obtained in facilitating creative thinking abilities for fluency 36%, flexibility 21%, originality 12% and elaboration 32% (Hufri et al., 2020). The existing learning modules can develop students' ability to understand material, but are still general in nature and do not facilitate students in improving their creative thinking abilities. With this e-module, students can develop creative thinking skills and can evaluate which parts of creative thinking indicators they have not mastered well. The use of learning modules is expected to make it easier for students to know and develop creative thinking skills in basic electronics courses so that they can increase student competence in the material and also optimize creative thinking abilities. One of the factors that can support to improve creative thinking skills is e-module. E-modules a teaching material packaged digitally. E-module can help teachers facilitate students in learning (Wulansari et al., 2023).

**Method**

This study is a research and development (R&D) type. The development model used is the ADDIE model which has 5 stages, namely analyzing, designing, developing, implementing, and evaluating with the cycle described by (Muruganatham, 2015). The research carried out is research and development (R&D), namely the development of basic electronics e-modules integrated with problem solving models to improve students' mastery of concepts and creative thinking. The steps of the ADDIE model are as shown in Figure 2.

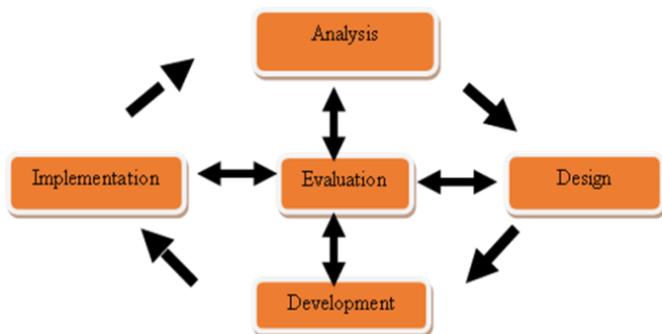


Figure 2. The ADDIE model development steps

The instrument used to collect validity data is a validity test instrument for basic electronics e-modules integrated with problem solving models to improve students' mastery of concepts and creative thinking by experts using expert validation sheets. The basic

electronics e-module integrates problem solving models to improve students' mastery of concepts and creative thinking must be validated by experts to determine the accuracy of the constituent components before this e-module is tested. The expert validation instrument was prepared based on the indicators determined for the basic electronics e-module integrated with problem solving models to improve students' mastery of concepts and creative thinking.

The validity test carried out by three expert validators using an expert review sheet with 5 aspect, namely material substance, learning design, visual communication display, software usage, integration of problem solving models. Assessment is carried out based on a Likert scale. The basic electronics e-module validation results were analyzed using the V-Aiken equation, the interpretation of the V values is presented in Table 1.

$$V = \frac{\sum s}{[n(C-1)]} \tag{1}$$

With  $s = r - lo$ ,  $lo$  = the lowest rating score,  $C$  = the highest rating score,  $r$  = the number given by the rater and  $n$  = many validators. At the end of the assessment, the value of the content validity of the instrument was obtained.

**Table 1.** Interpretation of V-Aiken

Value V-Aiken	Criteria
$V \geq 0.8$	Valid
$0.4 \leq V < 0.8$	Currently
$V < 0.4$	Less Valid

Aiken's Modification (Retnawati, 2016)

To understand this research, you can see the research flow in Figure 3.

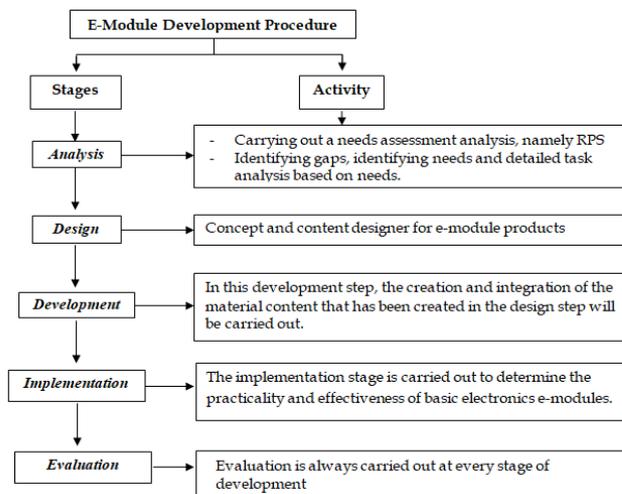


Figure 3. Research flow

## Result and Discussion

The ADDIE model is the most popular model used for developing creative learning materials. The development model consists of 5 stages, namely Analysis, Design, Development, Implementation and Evaluation (Yulia et al., 2023). The advantages of the ADDIE model include that its description appears more complete and describes a systematic approach to instructional development (Sugihartini & Yudianta, 2018). The results of this research were obtained through research and development of the ADDIE model. Each stage has certain activities that must be carried out, a product in the form of an e-module containing learning components that integrate problem solving models. The following are the stages of development based on the ADDIE model.

### Analysis

At the analysis stage, several activities are carried out, including: First, carrying out a needs assessment analysis, namely RPS, this analysis is to determine the competencies that students must have after completing lectures. Second, carry out a task analysis, to find out the problems faced and require solutions, namely by identifying gaps, identifying needs and detailed task analysis based on needs.

### Design

Design activities are a systematic process that starts from designing the concept and content in the product. At this stage, the design of the e-module is carried out. This e-module was prepared in accordance with the e-module development guidelines (Prastowo, 2011) by integrating problem solving models in it.

### Development

Development is the process of turning a design into an Integrated Basic Electronics E-Module with a Problem Solving Model to Improve Students' Mastery of Concepts and Creative Thinking. In this development step, the creation and integration of the material content that has been created in the design step will be carried out. At this stage a storyboard will be created, the material content will be written and the required graphics will be created. This e-Module was developed using the Flip PDF Professional application. The module content includes basic electronics material, namely diode material and its applications.

The result of this research is the validation of a basic electronics e-module integrated with problem solving models. The results obtained after validation by experts will then be revisions are carried out taking into account suggestions and input regarding strengths, weaknesses, and limitations of this product. Validation

of this basic electronics e-module is seen from the instrument validity. Validation data by experts is used to see whether the e-module is feasible or not basic electronics and for guidance in revising products. This integrated basic electronics e-module with problem solving models was validated by 3 expert lecturers. Average value for one component is obtained by dividing the values of all indicators in the product validation component as many as the number of indicators. The validation outcomes of the expert validator were used to determine the viability of the research product. The results of the validity of the basic electronics e-module are presented in Table 2.

**Table 2.** Basic Electronics E-Modules Validation Results

Component	Aiken's Value	Criteria
Material substance	0.96	Valid
Learning design	0.88	Valid
Visual communication	0.98	Valid
Software usage	0.88	Valid
Integration of models	0.63	Currently
Average	0.87	Valid

Based on the data in Table 2, the five validation aspects of the Aiken's V value are  $> 0.6$ . From the five aspects of validity, one aspect, namely the integration of problem solving models in basic electronics e-modules, is in the medium category. So the average value obtained according to the validator is 0.87. It can be interpreted that the basic electronics e-module integrates problem solving models to improve students' mastery of concepts and creative thinking in the valid category. The resulting e-module meets feasibility aspects both in terms of content, learning design, visual appearance and use of supporting software. These four components are the main components that must be considered in developing ICT-based teaching materials (Kemendiknas, 2010). This means that the basic electronics e-module integrated with problem solving models can be used in the electronics learning process.

In addition, e-modules can encourage students to increase self-confidence to take an active role, as well as courage and confidence in expressing opinions in the learning process. Then the advantage of using this e-module is that it can be used for independent learning without a teacher. Because, one of the criteria for a feasible e-module must be able to facilitate students in investigating the information contained in the e-module (Ananda & Usmeldi, 2023).

Development of an integrated basic electronics e-module with problem solving models to improve students' mastery of concepts and creative thinking regarding diodes and their applications. This e-module is designed based on the e-module structure which consists of: Cover, Foreword, Instructions for Using the

E-module, Learning Achievements and Objectives, Learning Activities, Student Worksheets, Exercises, Evaluation and Bibliography. The following displays the e-module being developed.



Figure 4. Cover of the e-module

Figure 4 shows the initial appearance of the e-module, namely the cover. The cover displays the title of the material, author's name, affiliation. This e-module can be accessed online by students via the link provided.

This e-module is integrated with the problem solving model, as shown in Figure 5.

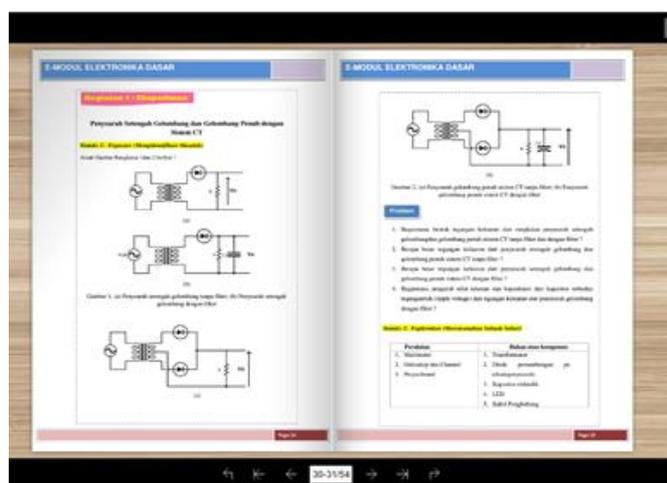


Figure 5. Integrated problem solving model

Figure 5 shows the student worksheet section contained in the e-module. This section follows the steps

of the problem solving model, namely Exposure, Exploration, Execution, Evaluation (Prem, 2020).

*Implementation*

The implementation of the Integrated Basic Electronics E-Module Problem Solving Model to Improve Student Mastery of Concepts and Creative Thinking will be tested on physics students FMIPA UNP. The implementation stage is carried out to determine the practicality and effectiveness of basic electronics e-modules.

*Evaluation*

The last stage of product development that has been made is the revision of the final product from the trial stage that has been used by students and educators during the learning process. This evaluation stage is carried out with the aim of revising requirements for the feasibility of the final product.

**Conclusion**

Based on the research results obtained and the discussion that has been explained, it can be drawn the conclusion is that the validity of the basic electronics e-module integrated with problem solving models to improve students' mastery of concepts and creative thinking has an average value of module validity from expert lecturers is 0.87 and is included in the valid criteria. This reveals that the basics electronics e-module integrated problem solving model meets the valid criteria.

**Acknowledgments**

Thank you to the Dean of FMIPA UNP, Head of Masters Physics Study Program, Lecturers and Students of Physics' Department UNP and all parties so that this research can be carried out properly.

**Author Contributions**

Conceptualization, F.T.; methodology, F.T.; data curation, F.T.; writing – original draft preparation, F.T.; writing – review and editing, F.T and A.A.; supervision, A.A.; funding acquisition, F.T. All authors have read and agreed to the published version of the manuscript.

**Funding**

This research was privately funded by the author.

**Conflicts of Interest**

The authors declare no conflict of interest.

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