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Validity of a Physics E-Module Based on Creative Problem Solving Model Integrated With Renewable Energy

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Abstract: E-modules are one of the teaching materials that can support the goals of an independent curriculum because with e-modules students can learn easily, can be accessed anywhere and at any time. The CPS model can train students to be skilled and creative in solving problems. One of the characteristics that needs to be integrated in teaching materials is energy saving. The aim of the research is to produce e-modules that meet the criteria of being feasible, practical and effective in improving student learning outcomes. This e-module was developed through research and development using the EDR (Educational Design Research) model with the following stages: analysis and exploration, design and construction, and evaluation and reflection. The Physics E-Module was developed for Work and Energy material which was developed based on Creative Problem Solving steps. Then this e-module also contains information about renewable energy and several energy saving invitations to students. The physics e-module that was developed met the very valid criteria, with detailed scores: 87.5 for the content suitability category, 87.5 for the e-module presentation category, 95.45 for the graphics category, and 91.67 for the language category. Thus, the physics e-module received a very valid assessment for all validation categories.

Keywords: CPS; E-module; Energy renewable; Validity

Introduction

Quality education will produce the nation's next generation with quality, character and competitiveness. The quality of a nation's education can be seen in the curriculum used in that country (Rahayu et al., 2022). In this case, the Indonesian government is implementing improvements in the quality of education through curriculum improvements (Ardianti et al., 2022; Jufriadi et al., 2022). The independent curriculum is the curriculum applied in Indonesian education today. The independent curriculum is a learning design that focuses on freedom and creative thinking, thus allowing students to learn calmly and happily so that students can show their natural talents (Khoiri et al., 2021). The Merdeka curriculum prepares a creative and innovative generation of the nation so that it can compete globally. The independent curriculum facilitates students' learning in a fun way, so it needs to be supported by the role of the teacher as a facilitator. Teachers are expected to be able to develop teaching materials that enable students to learn anywhere and anytime (Indariani et al., 2019). Digital teaching materials are an option that students can access anywhere and anytime so that students can learn easily and happily (Fitri et al., 2023). An independent curriculum allows students to self-regulated learning, which provides space for students to learn at their own pace with the teacher as the facilitator (Dewi et al., 2023).

On the other hand, the independent curriculum also facilitates teachers to be independent in determining the teaching tools used in learning so that learning can be adjusted to students' needs (Dewi et al., 2023). Digital teaching materials can accommodate these needs in learning. However, the reality in the field is that the availability of digital teaching materials is still lacking, this is in accordance with research results (Dewi et al., 2023), which states that the availability of digital teaching materials in schools is still lacking (Herawati et al., 2018). This is reinforced by the research results of

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Fitri et al. which state that the number of digital teaching materials as teaching materials that enable students to learn independently is very limited (Fitri et al., 2023). The independent curriculum also aims to improve students' communication, collaboration, critical thinking and creative skills (Jufriadi et al., 2022; Kurniawan et al., 2021). This is because the implementation of the independent curriculum focuses on increasing student creativity (Riyadi et al., 2020). In implementing an independent curriculum, it needs to be supported by a learning model that allows the development of student creativity.

The Creative Problem Solving (CPS) model is a learning model that can increase students' creativity in solving problems (Kim et al., 2019). The application of the CPS model can be done by developing teaching materials according to the CPS model steps (Widya et al., 2021). CPS facilitates students in independent and group learning and fosters student creativity in solving problems with various solutions (Wang, 2019). Apart from that, the merdeka curriculum also prioritizes character development in every learning process (Sumarsih et al., 2022). The learning process emphasizes character that enables students to face world problems globally (Alwi et al., 2022). One of the current global problems is the energy crisis. The energy crisis not only threatens survival in developed countries but also threatens survival globally. This issue is caused by an imbalance between energy availability and demand (Chamdareno et al., 2019).

Along with the increase in human numbers and technological developments, future energy needs are projected as follows:

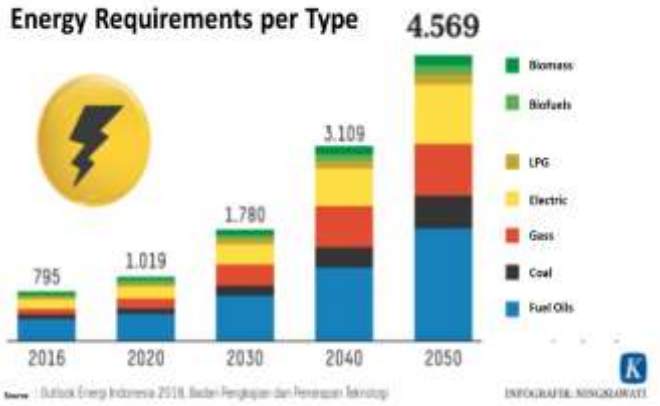

Figure 1. Projection of Energy Needs in the Future (Fahmi et al., 2022)

Based on Figure 1, information is obtained that energy needs will continue to increase until 2050. The increase in energy demand is not balanced with energy production, causing vulnerability to national and global energy security conditions (Chamdareno et al., 2019). Therefore, the role of education for the community (including students) is needed to save energy use as a form of national defence (Khotimah, 2017). One form of education's role is to integrate renewable energy into learning as a form of introducing renewable energy to students (Widya et al., 2017). Based on the research results of Rohim et al., information was obtained that students' energy-saving awareness in Indonesia still needs to improve (Rohim et al., 2022). Through the introduction of renewable energy by integrating it into learning, it is hoped that it can instil energy-saving characteristics in students.

Based on the problems above, it is necessary to develop digital teaching materials based on the CPS model integrated with renewable energy to form energy-saving characters in students. It is due to several things: (1) the availability of teaching materials in digital form in schools is not yet complete; on the other hand, the independent curriculum demands the use of technology in learning (Sumarsih et al., 2022), the use of e-modules in learning is one of the reasons; (2) the focus of implementing the independent curriculum is developing creativity, the CPS model is a learning model that can develop student creativity where students are allowed to find several solutions to a problem and choose the best solution (Nurfarida et al., 2021); (3) the independent curriculum is also focused on developing student character, emphasizing character development to prepare students to face global problems, one of which is the energy crisis, students need to be introduced to the solution to the energy crisis, namely renewable energy, with the hope that energy character will emerge in students (Desnita, 2015). Apart from that, cultivating energy-saving characters is expected to foster students' sense of responsibility in using energy according to their needs and considering energy availability in the future (Khotimah, 2017)

Method

Research design and method should be clearly defined. This type of research is research and development using the EDR (Educational Design Research) development model with the following stages:

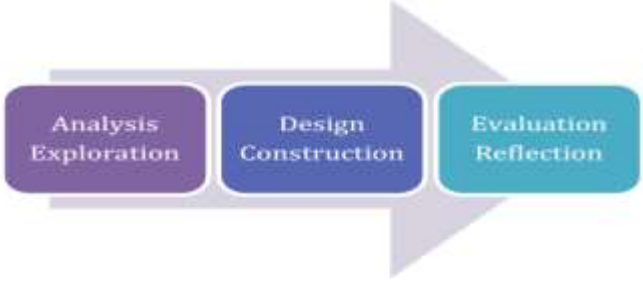

Figure 2. General model for conducting educational design research (McKenney et al., 2021)

This development model consists of three steps. The first step is the analysis and exploration of development needs. Research and exploration are carried out by collecting information related to e-module needs from potential users (teachers and students). The investigation was also carried out through document reviews about curriculum development and the energy crisis. The second step of this research is design and construction, at this stage, a CPS-based e-module design based on integrated renewable energy is carried out, referring to the results of the needs analysis. The final step is evaluation and reflection, carried out through user trials to see the practicality and effectiveness of the e-module that has been developed.

This article discuss about second stages (design and construction). The things that are done at this stage are: a) reviewing various materials to obtain information related to the development focus that the researcher hopes for. information is collected, then the researcher; b) create a general design in the form of a storyboard for the integrated renewable energy physics E-module based on the CPS model; c) test the feasibility of the general design of the E-module; d) after being declared feasible, researchers carry out construction of the E-module product; e) validation/testing of the feasibility of construction results of integrated renewable energy physics e-module products based on the CPS model, integrated renewable energy based on the CPS model by experts.

Result and Discussion

The Physics module was developed for Work and Energy material. The E-Module was developed based on Creative Problem Solving steps. This e-module also includes information about renewable energy and several energy-saving invitations to students.

The initial part o the module consists of a cover, foreword, table of contents, learning outcomes, learning objectives, and initial information related to the energy crisis and renewable energy.

Figure 3. Look cover

Figure 4. Information about saving energy

The contents of the e-module consist of the title, learning objectives, videos related to the material, and material presented in accordance with creative problem solving steps.

Figure 5. E-module look

The final part of the e-module consists of: multiple choice questions, answer key, and bibliography.

After the e-module construction is complete, the next validity test is carried out by experts. The validation results are as follows: First, eligibility of content: In the following image, the e-module validation results for the content eligibility category are displayed:

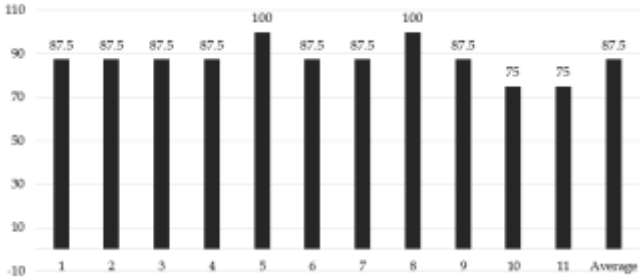

Figure 6. Eligibility of content

Note: First indicator is the topics presented in the e-module are in accordance with the demands of Learning Outcomes. Second, the facts presented are appropriate to the topic. Third, the facts presented are in accordance with the theory. Fourth, the concepts presented do not have a double meaning. Fifth, the material provided is in accordance with the Business and Energy material. Sixth, the examples provided are up-to-date and contextual. Seventh, the description of the material and examples provided are relevant and attract students' attention. Eight, the example questions provided can help students understand the material. Ninth, the E-module was developed based on the Creative Problem Solving (CPS) model. Tenth, the steps of the CPS model are clearly visible in the e-module. Last indocator is renewable energy is clearly integrated into the e-module. Based on the image above, information is obtained that the e-module is very valid for the content suitability category, with an average score of 87.5. In several e-module statements, the maximum score was 100, and the minimum score was 75.

The second category is presentasion: In the following image, the results of the e-module validation for the presentation category are shown:

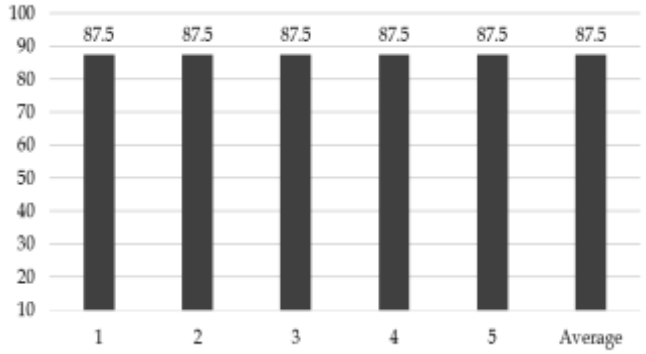

Figure 7. E-module presentation validation results

Note: First Indicator is the sentence structure needs to be more clear and clear. Second, the CPS-based e-module integrated with renewable energy contains clear learning objectives. Third, the E-module based on CPS integrated with renewable energy directs students to build their concepts. Fourth, presentation of the material scheme in accordance with the characteristics of the material. Fifth, order of presentation according to indicators and subject matter. Based on the image above, information is obtained that the e-module is very valid for the presentation category with an average score of 87.5.

Third category is graphics: The following image shows the results of the e-module validation for the graphics category:

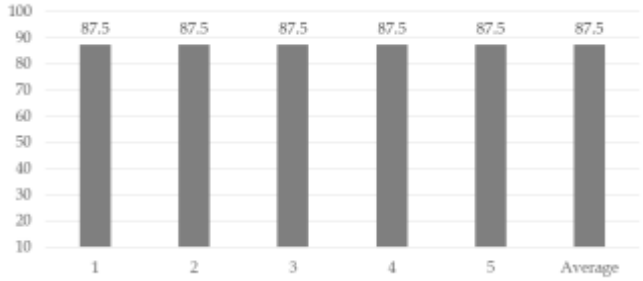

Figure 8. E-module graphics validation results

First indicator is the introductory page of the e-module consists of a cover, instructions for using the module, information about renewable energy and a table of contents. Second, the e-module page is presented systematically, starting from the title, learning material, and example questions. Third, on the closing page of the e-module, there is a bibliography. Fourth, the description of the material in the e-module is adapted to the creative problem-solving (CPS) model. Fifth, be consistent in using symbols/symbols. Sixth, there is a balance between picture illustrations and writing. Seventh, the combination of writing colours in the e-module is attractive. Eighth, the font used is clear and legible. Ninth, regular layout. 10. Simple and attractive appearance design. Last, the videos and images displayed are clear. Based on the image above, information is obtained that the e-module is very valid for the graphics category, with a score of 95.45.

Last category is language: In the following image, the e-module validation results for the Language category are shown:

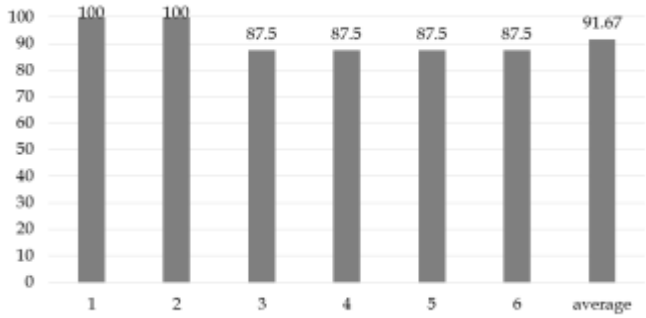

Figure 9 .Language validation results in e-module

First indicator is the introductory page of the e-module consists of a cover, instructions for using the module, information on renewable energy and a table of contents. Second, the e-module page is presented systematically, starting from the title, learning material, and example questions. Third, on the closing page of the e-module, there is a bibliography. Fourth, the description of the material in the learning model is adapted to the creative problem-solving (CPS) model. Fifth, be consistent in using symbols. Sixth, there is a

balance between picture illustrations and writing. Based on the image above, information is obtaned that the e-module is very valid for the language category. The average validation score for the language category is 91.67, which is a very valid category.

Experts who act as validators stated that the physics e-module based on the integrated renewable energy CPS model was deemed worthy of trial. E-modules have valid categories for all categories, namely appropriateness of content, graphic presentation, and language. The e-module is considered to be in accordance with the demands of learning outcomes, the facts presented are appropriate to the topic, the example questions provided can help students understand the material, the e-module is developed according to the steps of the CPS model, and the integration of renewable energy is clearly visible in the presentation of the material. It is in line with the results of Maulidah's research, which states that the e-module developed is based on the third valid CPS model in terms of material (Hasanah et al., 2023). CPS can clarify the presentation of learning material and make it easier to guide students in finding solutions to problems and choosing the best solution (Widya et al., 2019). Apart from that, the physics e-module based on the CPS model integrated with renewable energy also received a valid title. The e-module is designed using the flpthm5 application, where fliphtml5 is a software used to create e-module teaching materials which can include various types of media, including audio, video, and animation (Febriansyah et al., 2021; Nurhayati et al., 2022; Wati et al., 2022). In this way, developing e-modules using fliphtml5 can make it easier to create e-modules and help teachers prepare interesting teaching materials to increase students' learning motivation (Andermi et al., 2021; Putri et al., 2021). The integration of renewable energy in teaching materials was also considered feasible by the validator; the main e-module material is closely related to renewable energy, namely work and energy material. The presentation of work and energy materials becomes more complete with additional information regarding renewable energy. Apart from that, the e-module also includes an invitation to save energy, with the hope that students will develop an energy-saving character in themselves (Khotimah, 2017).

Conclusion

The physics e-module developed meets the very valid criteria, with detailed scores: 87.5 for the content suitability category, 87.5 for the e-module presentation category, 95.45 for the graphics category, and 91.67 for the language category. Thus, the physics e-module received a very valid rating for all validation categories.

Author Contributions
Need analysist, W, F.W.G, R.A; designing product, W, M.I, F.W.G; validation, R.A, W; data analysist, F.W.G, R.A, W, M.I; writing original draft preparation, W, M.I; editing: F.W.G, R.A.

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Conflicts of Interest
No conflict interest.

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