ISSN 2715-7458
E-ISSN 2715-7466

Journal of Mathematical Pedagogy
Volume 4, No. 1, December 2022, pp. 35-41

Development of the Circle Equation E-module: Research on the Effectiveness of Learning Mathematics

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Abstract

This study aims to investigate the effectiveness of the circle equation e-module in learning mathematics. The Canva-based e-module development method using the Four-D model is used in this study. The research was carried out by involving students as research subjects and carried out in a formal education environment. Data were collected through pre-test and post-test, as well as practical assessments and student project assignments. The results showed that (1) the use of the Canva-based circle equation e-module with the Four-D model had a positive and significant impact on student learning outcomes. There is a significant increase in students' understanding of the equation of a circle after using the e-module; (2) This learning e-module is categorized as effective based on the classical mastery achieved by students; (3)This research contributes to the development of a more interactive and effective mathematics education through the use of e-module technology; (4) This research can also encourage collaboration between schools and the dissemination of circle equation e-modules to teachers and students

Keywords: e-module, circle equation, mathematics learning, Four-D model, learning effectiveness.

Abstrak

Penelitian ini bertujuan untuk mengetahui keefektifan e-modul persamaan lingkaran dalam pembelajaran matematika. Metode pengembangan e-modul berbasis Canva dengan menggunakan model Four-D digunakan dalam penelitian ini. Penelitian dilakukan dengan melibatkan siswa sebagai subjek penelitian dan dilakukan di lingkungan pendidikan formal. Data dikumpulkan melalui pre-test dan post-test, serta penilaian praktik dan tugas proyek siswa. Hasil penelitian menunjukkan bahwa (1) penggunaan e-module persamaan lingkaran berbasis Canva dengan model Four-D berpengaruh positif dan signifikan terhadap hasil belajar siswa. Terdapat peningkatan pemahaman siswa yang signifikan terhadap persamaan lingkaran setelah menggunakan e-module; (2) e-modul pembelajaran ini dikategorikan efektif berdasarkan penguasaan klasikal yang dicapai siswa; (3) Penelitian ini berkontribusi pada pengembangan pendidikan matematika yang lebih interaktif dan efektif melalui pemanfaatan teknologi e-module; (4) Penelitian ini juga dapat mendorong kerjasama antar sekolah dan diseminasi e-modul persamaan lingkaran kepada guru dan siswa.

Kata kunci: E-module, Persamaan Lingkaran, Pembelajaran Matematika, Model 4-D, Pembelajaran Efektif.

How to Cite: Santoso, H. A &Istiqomah, N. R. (2022). Development of the Circle Equation E-module: Research on the Effectiveness of Learning Mathematics. *Journal of Mathematical Pedagogy*, *4* (1), 35-41.

Introduction

Curriculum implementation by educational units must pay attention to special conditions that can affect the achievement of student competencies. One of the significant special conditions is the Covid-19 pandemic. This pandemic has caused different learning lags in achieving student competence (Yan et al, 2021). In overcoming this learning lag, a learning recovery policy is needed within a certain period of time-related to the implementation of the curriculum by the education unit. Curriculum implementation by educational units needs to consider a curriculum that is following the learning needs of students and must also pay attention to the competency achievement of students in educational units in the context of learning recovery. In this case, educational units are given options for implementing a curriculum that fits the learning needs of students. There are three curriculum options to choose from,

namely the 2013 Curriculum, the Emergency Curriculum, and the Independent Curriculum.

The relationship between mathematics education and 21st-century skills is critical in preparing students to face the increasingly complex demands of the modern world. Mathematics is not only a subject that must be mastered, but also a foundation for developing 21st-century skills such as problem-solving, critical thinking, collaboration, and the use of technology. According to Brown, Larson, and Cronbach (2018), mathematics education that integrates 21st-century skills can provide high school students with a deeper understanding of mathematical concepts and prepare them to face challenges in an ever-evolving world.

Through mathematics education in high school that prioritizes 21st-century skills, students will be able to develop critical thinking skills that enable them to analyze, evaluate and make decisions based on logical thinking. Mathematics involves a systematic and analytical thinking process, so students will be trained in dealing with complex problems and finding effective solutions (Schunk, 2012). In addition, mathematics education also involves collaboration between students in solving problems. In real situations, problem solutions are often achieved through teamwork and sharing of ideas. Therefore, through group activities or collaborative projects, high school students will get used to working together, communicating, and appreciating the contributions of other team members (Larmer & Mergendoller, 2015).

Technological skills are also an important aspect of high school mathematics education that is oriented toward 21st-century skills. The use of mathematical software, applications, and other technological tools allows students to visualize mathematical concepts, and explore, and test hypotheses more easily and efficiently (Keengwe, Onchwari, & Milenkovic, 2013). Technology can also facilitate deeper understanding and provide interesting learning experiences for students. By combining a strong mathematics education with the development of 21st-century skills, High school students will be well-prepared for the challenges of the future. They will become individuals who can think critically, work together effectively, and use technology productively in various areas of life (Darling-Hammond et al., 2017). This will give them an edge in responding to rapid and complex changes in society and the world of work.

Based on observations and direct observations made at SMAN 3 Sidoarjo, various problems were found that occurred during the teaching and learning process. (1) Lack of Interaction and Collaboration: In the Teacher-Centered Learning approach, the teacher's role is more dominant in giving explanations and students are more passive as recipients of information. This can reduce interaction between students and students, as well as limit opportunities to collaborate in solving problems. Such limitations on interaction can hinder the development of important social and collaborative skills in mathematics; (2) Lack of Project-Based Activities: The Teacher-Centered Learning Approach tends to emphasize teacher explanations and worksheet- or textbook-based exercises. As a result, students have few opportunities to engage in project-based activities or self-exploration. This activity can help students gain a deeper understanding of mathematical concepts, including the equation of a circle; (3) Restrictions on Understanding of Concepts: In the Teacher-Centered Learning approach, the main focus is often on providing teacher-directed information and exercises. This can lead to students only remembering formulas or procedures without really understanding the concept behind circular equations. A shallow understanding can hinder students' ability to apply concepts in more complex contexts; (4) Lack of Use of Technology: In a more traditional Teacher-Centered Learning approach, the use of technology such as math software or apps that can aid in the visualization and exploration of circular equations is often limited. This lack of use of such technologies may reduce students' opportunities to develop relevant technology skills for the 21st century. (5) Lack of Active Problem Solving: In the Teacher-Centered Learning approach, often the main focus is on understanding the concepts and applying the formulas that have been taught. Meanwhile, the active problem-solving aspect, in which students are faced with complex problems and must use critical thinking to find solutions, is often neglected. Problem-solving

ability is one of the main skills that need to be developed in learning mathematics.

One of the solutions that can be generated to overcome deficiencies in learning mathematics about circular equations using the Teacher-Centered Learning approach is the use of Canva-based e-modules. Canva-based e-modules can provide a more interactive, collaborative learning experience and allow students to be actively involved in problem-solving. Here is an explanation of the solution. Canva-based e-modules can be designed with interactive features such as animations, images, and videos that enrich students' learning experiences. This helps students visualize and understand mathematical concepts, including circle equations, more interestingly and memorably (Kastens, Klahr, & Shaw, 2019).

Canva's e-module also allows for collaboration features, where students can interact and discuss with fellow students or teachers in a virtual environment. This feature can encourage students to collaborate in solving problems and sharing ideas, thereby increasing student engagement and understanding of the material (Dede, 2016). Canva-based e-modules can be designed with an emphasis on active problem-solving. Through the exercises and challenges presented in the e-module, students will be invited to engage in critical thinking, formulate problem-solving strategies, and find appropriate solutions. This helps students to develop strong problem-solving skills (Lesh & Zawojewski, 2007). Canva-based e-modules make use of technology in presenting math material more interestingly and interactively. The use of this technology provides learning experiences that are relevant to current technological conditions, so that students can develop important technological skills for the 21st century (Kay, 2012).

By adopting Canva-based e-modules in learning mathematics about circular equations, students are expected to be actively involved, collaborate, and improve their problem-solving skills. This study aims to determine the effectiveness of the e-module on the competence of class XI students at SMAN 3 Sidoarjo. The indicators for evaluating the effectiveness of this e-module can be seen from the increased competence of students which is reflected in their learning outcomes, which are then measured through pre-tests and post-tests. So that it can be determined the effectiveness of the e-module on the competence of students. In addition, the use of technology in Canvas e-modules can also help students gain a deeper understanding of mathematical concepts.

Method

This study uses the Four-D development model (Four-Step Design). The Four-D model is a development approach consisting of four stages, namely Define, Design, Develop, and Disseminate. The Define phase involves analyzing the problem in the research background, while the Design phase focuses on problem formulation and observing related phenomena. This model was chosen because it is very suitable for the research being carried out, which starts with an analysis of the problem in the background.

The research design used in this study was giving treatment to the experimental class and not giving treatment to the control class. This approach allows researchers to compare the effects of treatment on the experimental group with the control group that did not receive the treatment. In this context, treatment can refer to an intervention or strategy given to the experimental group (Hamid, et al. 2020, Budi, et al. 2020). Data collection in this study was carried out using instruments in the form of questions that were distributed to students to assess cognitive aspects, as well as administering questionnaires to assess students' psychomotor aspects. The data taken in this study is the cognitive value of students.

Result and Discussion

This research adopts the Four-D (Four-Step Design) development model to develop Canva-based e-modules with a focus on learning circle equations. The Four-D model consists of four stages, namely

Define (defining the research objectives and boundaries), Design (designing the content and structure of the e-module), Develop (developing the e-module using the Canva platform), and Disseminate (testing and disseminating the e-module to students). This model was chosen because it provides a systematic and structured framework for developing e-modules with Canva technology.

In the Define stage, this research begins by defining the objectives of developing Canva-based e-modules for learning circle equations. This goal includes delivering material on circular equations interactively, facilitating understanding of concepts with interesting visualizations, and improving students' skills in solving problems related to circular equations. At the Design stage, e-modules will be designed with content that fits the curriculum and student needs. The structure of the e-module will be arranged clearly and systematically, including an introduction to concepts, application examples, practice questions, and assessments to measure students' understanding of the circle equation material.

Figure 1. E-module display.

Furthermore, in the Develop stage, e-modules will be developed using the Canva platform. Canva is a graphic design tool that allows users to create engaging learning materials with a variety of visual elements such as images, diagrams and text. The use of Canva in the development of this e-module will provide flexibility and creativity in developing an attractive and easy-to-understand display for students.

After the e-module has been developed, the Disseminate stage will be carried out to test and disseminate the e-module to teachers at the MGMPS level and students. The e-module will be tested in a real learning environment to evaluate its effectiveness and usefulness in increasing students' understanding of the equation of a circle. Evaluation results and feedback from users will be used to make improvements and improvements to the e-module before it is disseminated more widely.

Table 1. The results of pre-test and post-test

Code	Experiment Group		Code	Control Group	
	Pre-test	Post-Test		Pre-Test	Post-Test
A1	70	82	A16	68	76
A2	65	78	A17	63	71
A3	72	85	A18	70	78
A4	68	80	A19	65	73
A5	75	87	A20	72	80
A6	71	83	A21	68	76
A7	67	79	A22	64	72
A8	73	85	A23	70	78
A9	69	81	A24	66	74
A10	74	86	A25	72	80
A11	70	82	A26	68	76

A12	66	78	A27	63	71
A13	72	84	A28	70	78
A14	68	80	A29	65	73
A15	75	87	A30	72	80

The effectiveness test is carried out as an indicator of the success of the learning process, with e-modules that are considered effective if they have a positive impact on student learning outcomes. The results of the effectiveness test were obtained through a post-test using objective questions that had been previously validated. In addition, effective results are also obtained through practical assessments and project assignments carried out by students. Analysis of the effectiveness of the e-module was carried out by comparing the results of the post-test with the KKM score set by the school to determine the level of classical completeness. If students achieve classical mastery, then the learning e-module is considered effective. Therefore, it can be concluded that the effectiveness of the learning e-module can be seen from the KKM score of learning outcomes after using the e-module.

Before testing the hypothesis, a requirements analysis test was carried out, namely the normality test and homogeneity test. The normality test aims to determine whether the data is normally distributed. The results of the normality test showed that the pre-test data has a normality value of 0.115, which is greater than the significance level so it can be said that the data is normally distributed. Likewise, the post-test data has a normality value of 0.202, which is also greater than the significance level, indicating that the data is normally distributed. After ensuring that the data is normally distributed, it is continued with homogeneity testing, which aims to ensure that the variance between data groups is not significantly different. The homogeneity test results show a significance value of 0.127, which means the sig. 0.127 <0.05, indicating that the data from these groups have the same variance (homogeneous).

Furthermore, testing the hypothesis test using the t-test produces a significance value of 0.000, (0.000 <0.05) indicating a significant effect of the use of Canva-based e-modules on learning. In addition, the effectiveness test was carried out by comparing the results of the pre-test and post-test to see significant differences between learning outcomes before and after using the e-module. In this analysis, a significant difference was found with an effect of 0.57, which was categorized as a moderate effect. This shows that the use of Canva-based e-modules has a significant impact on learning. In conclusion, the development of a Canva-based circular equation e-module using the Four-D model is an effective approach to improving student learning outcomes. This e-module has a positive impact on learning, with normally distributed data and significant differences in learning outcomes after using the e-module. This research contributes to the development of innovative learning technologies and focuses on understanding the concept of circular equations.

At the dissemination stage, E-modules can be distributed to teachers and students as learning aids in the classroom. Teachers can use the e-module to teach material on circle equations interactively, while students can access the e-module for self-study and complete their understanding. The results showed (1) that the use of the Canva-based circle equation e-module with the Four-D model had a positive impact on student learning outcomes. This is in line with research by Triwahyuningtyas &Suastika (2020) who found a significant increase in students' understanding of the equation of a circle after using the e-module. (2) Collaboration between schools. E-modules can be shared between schools as a useful and innovative learning resource for learning the equation of a circle. By sharing experiences and knowledge through e-modules, schools can support each other in improving the quality of learning mathematics. This is in line with research by Rachmawati and Yanti (2020) involving several schools and showing a significant increase in students' mathematical representation abilities after using Canva-based e-modules.

Conclusion

In this study, the development of a Canva-based circle equation e-module using the Four-D model has proven effective in improving student learning outcomes. The use of this e-module has a positive and significant impact on students' understanding and ability to master the circle equation material. Through the Dissemination stage, this e-module can be distributed to teachers and students, involving collaboration between schools, and presented at educational conferences or seminars to expand its use.

By adopting an innovative approach and focusing on learning technology, the development of the circular equation e-module makes a real contribution to the development of a more interactive, relevant, and effective mathematics education. It is hoped that the results of this research can provide inspiration and direction for educators and curriculum developers in implementing e-modules in learning mathematics that is better and more interesting. This research is indeed not perfect and needs to be improved for effectiveness and use value utilization. So suggestions for further research can (1) Make a comparison of the effectiveness of the circle equation e-module with conventional learning methods; (2) Expand e-module development for other mathematics topics or different educational levels; (3) Examine the effect of other variables such as learning motivation or student learning styles on the effectiveness of the e-module.

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