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DEVELOPING OF E-LEARNING BASED MATHEMATICS LEARNING MODULES TO IMPROVE PROBLEM SOLVING SKILLS OF STUDENTS

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ABSTRACT

The availability of learning modules that are valid and easy for students to understand is essential for achieving educational objectives. Limited problem-solving skills in the fundamental concepts of ordinary differential equations pose a significant challenge in the learning process. This research aims to enhance students' problem-solving abilities in the topic of ordinary differential equations through the development of a mathematics e-learning modules for students in the Mathematics Education Study Program. The research method employed is the ADDIE development model. Based on the research findings, the developed e-learning modules was validated by subject matter experts, yielding a score of 3.61, categorized as very good, while validation by media experts resulted in a score of 3.42, also categorized as very good. The evaluation from students regarding the e-learning modules received a score of 3.81, which falls into the very good category. Based on the assessment of quiz responses, the average score was 78.9, indicating an improvement in students' problem-solving abilities prior to using the e-learning modules, which had an average score of 59.8. It can be concluded that the e-learning modules on the concepts of ordinary differential equations is suitable for use in learning and can enhance students' problem-solving skills.

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1. INTRODUCTION

Problem-solving skills are the core of mathematics learning because they provide the critical and analytical thinking abilities needed to face challenges in everyday life(Khalid et al., 2020). Through problem-solving, students learn to identify problems, formulate

strategies, analyze information, and find effective solutions. By strengthening problem-solving skills, students can become more effective learners and better prepared to tackle challenges in various aspects of their lives(Ratnawati et al., 2018).

Students who struggle with problem-solving in basic differential equations often face difficulties in mastering the material(Khalid et al., 2020). The main challenges they encounter are related to understanding the concept of ordinary differential equations, finding solutions to these equations, and mastering algebraic concepts, which are prerequisites for understanding ordinary differential equations. This lack of problem-solving skills may occur because, in the differential equations course at STKIP Melawi, the material is presented only in PowerPoint format, which limits students' ability to explore, comprehend, and solve problems related to the content. Based on this issue, it is necessary to provide a way for students to explore learning materials in depth and enhance their problem-solving skills. This can be achieved by offering an e-learning modules that includes interactive games, educational content, videos with problem-solving examples, and quizzes to further develop students' problem-solving abilities. Additionally, at STKIP Melawi, there is no readily accessible and practical learning module, such as an e-learning-based module, available to students. This poses a significant obstacle to their understanding and problem-solving related to the material presented.

In previous research by (Islahiyah et al., 2021), a problem-based e-learning module was developed and found to be valid, practical, and effective for teaching mathematics in 11th-grade high school classes. In a study conducted by (Yuni et al., 2022), a constructivism-based learning tool in the form of an electronic module on analytic circle material was developed. The module was found to be valid, practical, and effective in enhancing problem-solving skills, achieving an effectiveness rate of 80.64%, which categorizes it as highly effective. Evaluation tests showed that the module effectively improved problem-solving skills, with 80% of students achieving the required mastery level. Additionally, research by (Pirma, 2023) developed an ethnomathematics-based e-module that met the criteria of validity, practicality, and effectiveness in enhancing students' mathematical problem-solving abilities. The primary difference in this research is that the focus is on developing an e-module aimed at improving problem-solving skills in higher education settings. The proposed research introduces an innovative approach by incorporating gamification elements, such as rewards, to increase student motivation and engagement. These rewards will be offered upon the successful completion of differential equations problems, designed to align with problem-solving skill indicators.

One solution that can be implemented is the development of an e-learning-based mathematics learning module. E-learning-based modules provide better accessibility for students to study the material anytime and anywhere (Nurhasanah et al., 2022). The development of e-learning modules presents the material in a more engaging way through interactive elements such as videos, animations, and interactive exercises, which can enhance students' interest and motivation in learning mathematics. Additionally, e-learning modules allow students to learn at their own pace and facilitate more personalized learning by offering more comprehensive explanations and adapting to individual learning styles. (A'yuni et al., 2023)E-learning modules play a crucial role in supporting more effective and efficient mathematics learning. Developing e-learning-based modules is an essential step in improving students' problem-solving skills in the topic of ordinary differential equations. With adequate access to these e-learnig modules, students can easily learn, understand, and refine their problem-solving skills related to the content within the e-learning modules. Indirectly, the development of e-learning modules can also improve critical thinking skills, preparing students to face or solve problems in daily life.

The research problem formulated in this study is: How can the development of an e-learning-based mathematics learning module improve problem-solving skills in the topic of ordinary differential equations for students of the Mathematics Education Study Program at STKIP Melawi? The purpose of this study is to enhance students' problem-solving skills in the topic of ordinary differential equations through the development of an e-learning-based mathematics learning module for students of the Mathematics Education Study Program.

2. METHOD

The method used in this research is a development method. In the context of developing an e-learning-based mathematics learning module, commonly known as an e-learning modules, the goal is to improve students' problem-solving skills in the topic of ordinary differential equations at STKIP Melawi. The development research method focuses on the development of the e-learning modules from the conceptualization phase to its implementation and evaluation. The research design used is ADDIE (Analysis, Design, Development, Implementation, Evaluation)(Kurnia et al., 2019). The steps of this research can be seen in the following diagram (Marniati et al., 2023).

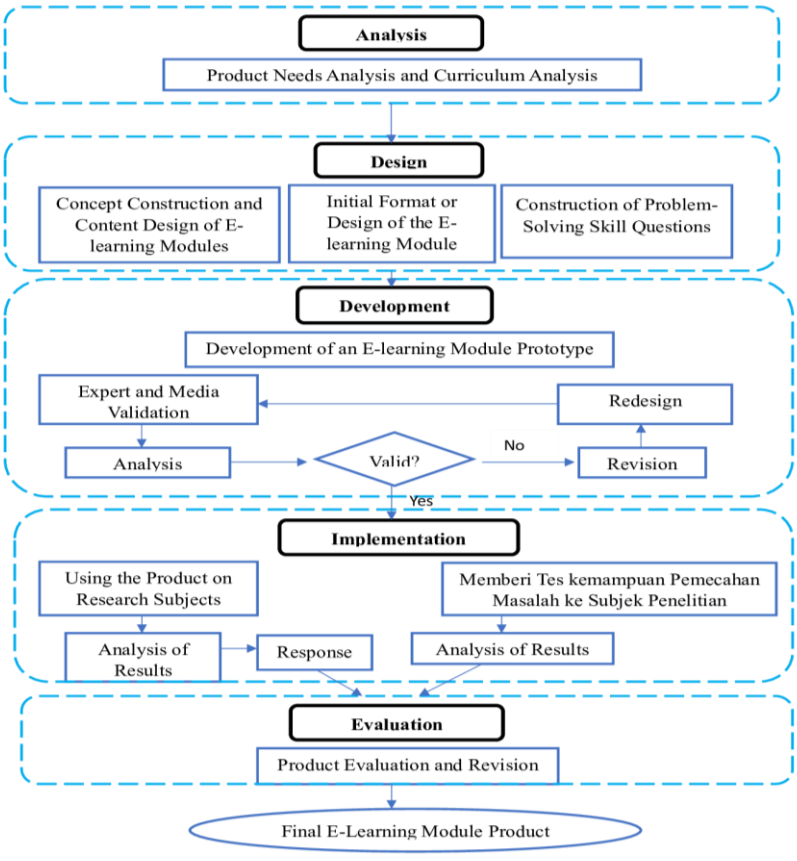

Figure 1. ADDIE Model Flowchart

The subjects of this study are 10 third-semester students of the Mathematics Education program at STKIP Melawi. The problem-solving skill indicators for the ordinary differential equations concept in the e-learning modules used in this study are adapted from (M et al., 2022) and include identifying sufficient data to solve the problem, creating a mathematical model of a problem and solving it, selecting and applying strategies to solve mathematical problems, and verifying the accuracy of the results or solutions. The research instruments used were questionnaires and problem-solving test questions in the form of quizzes embedded in the e-learning modules. The data collection techniques employed in

this study included questionnaires, tests, and documentation. The data analysis technique utilized was descriptive data analysis. The questionnaire results, which were qualitative data, were then converted into quantitative data using a Likert scale (Arigiyati et al., 2019). The steps for data analysis to assess the feasibility of the e-learning modules, as evaluated by subject matter experts, media experts, and student responses, are as follows.

Table 1. Questionnaire Assessment Criteria

Explanation	Score
SS (Strongly Agree)	4
S (Agree)	3
TS (Disagree)	2
STS (Strongly Disagree)	1

To calculate the average total score for each aspect of the questionnaire assessment from all evaluators, the following formula is used.

$$\bar{X} = \frac{\sum X}{n}$$

Explanation:
$\bar{X}$ = Average score
n = Number of evaluators
$\sum X$ = Total score

The next step is to convert the obtained average score into qualitative values (interval data) using a four-point scale based on the guidelines provided by (Mardapi, 2008) , as outlined below.

Table 2. Conversion of Scores into Categories

Score Interval	Qualitative Category
$X \geq 3$	Excellent
$3 > x \geq 2{,}5$	Good
$2{,}5 > x \geq 2$	Not Good / Poor
$X < 2$	Not Good / Bad

For the data analysis technique of the students' problem-solving test results, the scoring guide for written test answers is used. The steps involve assigning a score to each question, then summing the scores to determine the final grade.

2.1 Analysis Stage

The analysis stage in the design of the e-learning modules development consists of two aspects: needs analysis and curriculum analysis. Needs analysis requires a deep understanding of the purpose of developing the e-learning modules to enhance problem-solving skills and the needs in the learning process. Curriculum analysis involves identifying existing resources such as course literature, problem-solving skill indicators, and the necessary elements for e-learning modules development, as well as evaluating students' problem-solving abilities in the topic of ordinary differential equations. Curriculum analysis takes into account relevant curriculum aspects and assesses the alignment between the e-learning modules and the curriculum used in the Mathematics Education Study Program. By conducting a thorough analysis of these two aspects, the e-learning modules development can ensure that the learning objectives to improve students' problem-solving skills in the topic of ordinary differential equations are well achieved and aligned with the applicable curriculum requirements.

2.2 Design Stage

The design stage in the development of the e-learning modules involves creating the concept and layout of the e-learning modules based on the results of the previous needs and curriculum analysis. This stage includes developing an initial format or design for the e-learning modules, including content and exercises aligned with the problem-solving skill indicators. Additionally, this stage encompasses the development of learning materials that fit the e-learning modules design, such as user guides and other supporting resources. The e-learning modules design must also take into account ergonomic aspects and accessibility for users. By conducting a thorough design process based on prior analysis, the e-learning modules can be effectively developed to support an efficient learning process.

2.3 Development Stage

This stage involves turning the previously designed e-learning modules into a tangible and functional product. It includes the creation of a prototype based on the approved design. The development team is responsible for ensuring that the e-learning modules is efficiently developed and meets the established quality standards. During this stage, the team may also thoroughly test the prototype to ensure it performs according to the desired specifications. Additionally, the prepared learning materials, such as user guides and other supporting resources, can be integrated into the e-learning modules. Through careful development, the e-learning modules becomes a ready-to-use product for an effective learning process.

2.4 Implementation Stage

In this stage, the developed e-module is applied in actual learning settings. Before being implemented, the e-learning module undergoes a content validation process by media experts and subject matter experts. The validation instrument by media experts includes indicators such as the feasibility of design appearance, ease of use, consistency, usefulness, and graphics quality. The validation instrument by subject matter experts includes indicators such as the feasibility of content, language, and presentation. After revisions are made based on the feedback from the validators, the e-learning module can then be implemented. This step includes introducing the e-learning- modules to users, such as instructors and students, and conducting training or orientation sessions on how to use the e-learning module. During this stage, the team will monitor and support users in utilizing the e-learning module while also gathering feedback regarding their experiences and the e-learning modules performance. Additionally, this stage involves evaluating the e-learning modules usage process within the context of actual learning, which may include necessary adjustments or improvements to enhance performance and learning quality. Through a structured approach, the e-learning modules can be effectively integrated into the learning process and make a significant contribution to students' learning experiences.

2.5 Evaluation Stage

In this stage, the focus is on evaluating the effectiveness of the e-learning module in achieving learning objectives aimed at improving students' problem-solving skills in the topic of ordinary differential equations. This evaluation involves collecting data and information regarding users' experiences with the e-learning module during the learning process. This step also includes gathering feedback from users through surveys, interviews, and direct observations. Furthermore, the evaluation encompasses an analysis of the e-learning modules performance, such as its reliability, usability, and efficiency in supporting the learning process. The results of this evaluation are used to assess the extent to which the e-learning module has met the established learning objectives and to identify areas that require improvement or enhancement.

3. RESULTS AND DISCUSSION

3.1. Results

The research and development conducted resulted in an e-learning-based mathematics learning module in the form of an E-learning Modules on the Concept of Ordinary Differential Equations. The material on the concept of ordinary differential equations is a sub-topic within the Ordinary Differential Equations course in the third semester of the Mathematics Education Study Program at STKIP Melawi. This e-module was developed using the ADDIE development model, with the outcomes of each development stage described as follows.

3.1.1. Analysis

In the analysis stage, the method used by the researcher is observation, conducted while the researcher was teaching the ordinary differential equations course. The observation aimed to understand the curriculum in use, the learning activities, the teaching materials employed, and the students' problem-solving abilities.

The initial step in analyzing the product's needs is to evaluate the curriculum used in the Mathematics Education Study Program at STKIP Melawi. The purpose of this curriculum analysis is to ensure a clear direction for the development of the e-learning module. This analysis is conducted by gathering information related to the courses and materials that will be included in the e-learning module, based on the graduate learning outcomes and course learning outcomes aligned with the Mathematics Education Program curriculum.

Classroom learning activities begin with the instructor explaining the material, accompanied by examples. Students listen, take notes, and complete assignments as directed by the instructor. These activities are supplemented with question-and-answer sessions and group discussions. Some students still struggle to understand the material because they have not mastered the prerequisite concepts, particularly when solving problems related to the topic. The situation is further complicated by some students' lack of initiative to prepare themselves for understanding material related to the next class before the lesson takes place, which results in insufficient comprehension of the material presented and a reliance solely on the instructor's directions, indicating a lack of independence in their learning.

The instructor does not rely on a single teaching resource as a specific reference for instruction. Instead, the instructor uses various teaching materials each year, but these resources do not have legitimate campus usage rights. The teaching materials employed in class primarily consist of presentation slides created with PowerPoint. The course instructor recognizes the need to develop more engaging teaching materials that clarify the content presented, facilitate independent student understanding, and ease access to these resources.

The e-learning module to be developed must undergo feasibility testing to ensure that the teaching materials can be effectively used as intended and are accountable. Aspects of evaluation from expert theories are adapted to meet the needs of the assessment instruments for the e-learning module developed in this research.

In this study, problem-solving ability refers to the skills of students involving the application of concepts, methods, and mathematical strategies to solve mathematical problems. In the ordinary differential equations course, students face difficulties in addressing problems related to prerequisite material, such as differential calculus, integral calculus, and concepts of ordinary differential equations, including the understanding of ordinary differential equations, linear and nonlinear differential equations, initial value problems, and solutions to ordinary differential equations. An initial test to assess understanding and problem-solving related to the concept of ordinary differential equations

before using the e-learning module yielded an average score of 59.8, which falls into the insufficient category. To measure students' problem-solving abilities, a test instrument in the form of quizzes is included in the e-learning module. The indicators of problem-solving ability concerning the concept of ordinary differential equations used in this research, adapted from (Hendrycks et al., 2021), consist of identifying sufficient data to solve problems, creating a mathematical model of a problem and solving it, selecting and applying strategies to solve mathematical problems, and verifying the accuracy of the results or answers.

Based on the explanation above, there is a need for new development concerning the teaching materials used by creating an appropriate e-learning module for learning activities. This e-learning module should include the material on the concept of ordinary differential equations, present the content in a more engaging manner, enhance students' problem-solving abilities, facilitate access to the e-learning module, and improve students' independence in learning.

3.1.2. Design

The design process involves the design of the e-learning module for the concept of ordinary differential equations. This stage also includes the design of instruments to measure the feasibility of the developed e-learning module. The outline of the e-learning module contains the initial design of the content to be included in the e-learning module and the sequence of the presented material. Based on the analysis conducted, the e-learning module developed in this research consists of 8 subtopics: 1) Introduction to differential equations (differential calculus and integral calculus as prerequisite materials); 2) Definition of differential equations; 3) Types of differential equations; 4) Definition of ordinary differential equations; 5) Linear ordinary differential equations and nonlinear ordinary differential equations; 6) Solutions to ordinary differential equations; 7) Initial value problems; and 8) General and particular solutions.

The structure of the e-learning module generally consists of three main parts: the introduction, the content, and the conclusion. The introduction includes a preface, learning objectives, a game to review students' understanding of prerequisite material, and an introduction to differential equations. The content part comprises explanations of the material, example problems with links to YouTube videos, and practice questions. The conclusion contains a quiz to measure students' problem-solving abilities.

The material presented in the e-learning module covers the introduction to differential equations, including explanations of differential calculus and integral calculus, which are prerequisite materials for understanding the concept of ordinary differential equations, the definition of differential equations, various types of differential equations, the definition of ordinary differential equations, linear and nonlinear ordinary differential equations, solutions to ordinary differential equations, initial value problems, general solutions, and particular solutions. At the beginning of the learning session, a game is provided to review the prerequisite material previously studied. The game in the e-learning module consists of 3 levels related to the prerequisite material. Students who successfully complete the game at each level will receive additional points for their individual assignment grades. Each topic includes videos demonstrating how to solve problems and practice questions. After studying all the material, students complete the quiz questions. The quiz consists of multiple-choice questions, and feedback is provided in the form of scores so that students can assess their learning outcomes. The procedure for completing the quiz questions in the e-learning module must be recorded by the students and then submitted to measure their problem-solving abilities concerning the concept of ordinary differential equations.

The research instruments consist of a questionnaire and quiz questions. The instrument for measuring the feasibility of the e-learning module is designed in the form of a questionnaire using a 4-point Likert scale: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). These responses are then converted into scores of 4, 3, 2, and 1, respectively, according to the order of the statement responses. The development of the assessment items for the feasibility of the e-learning module considers the aspects of feasibility as stated in the guidelines for developing teaching materials, including content feasibility, language aspects, presentation aspects, and graphical aspects, as well as the criteria for developing learning applications, which include software aspects, learning design aspects, and visual communication aspects with detailed evaluation criteria. The arrangement of these instruments represents a general assessment, thus requiring re-grouping based on validation subjects in terms of content and media, as well as trial subjects (users). These assessments are reviewed to align with the assessment needs for the e-learning module developed in this research.

The content expert assessment instrument consists of 27 assessment items covering content, language aspects, and presentation aspects. The media expert assessment instrument consists of 28 assessment items covering screen design appearance, ease of use, consistency, utility, and graphical aspects. The student response questionnaire to the e-learning module consists of 29 assessment items covering material presentation aspects, language aspects, utility aspects, and graphical aspects.

3.1.3. Development

The development stage consists of three steps: the development of the e-learning module, the development of instruments, and the assessment of the e-learning module. The results of the development stage for the e-learning module on the concept of ordinary differential equations are as follows.

The e-learning module is developed using the (M et al., 2022)Flip Pdf application to create the cover, preface, learning objectives, and the e-learning module content, initially drafted in Microsoft Office Word 2019 before being converted to PDF format. Additionally, the game at the beginning of the learning session is created using Macromedia Flash. Supporting material simulations in the form of videos are linked to YouTube. The quiz at the end of the e-learning module is created using Flip Pdf(Rohmah & Sakti, 2022). All materials, including content, games, videos, and quizzes, are imported into the App Builder program or application, where the layout is designed, and then published in APK format. The development of the e-learning modules that have been created can be seen in the following image.

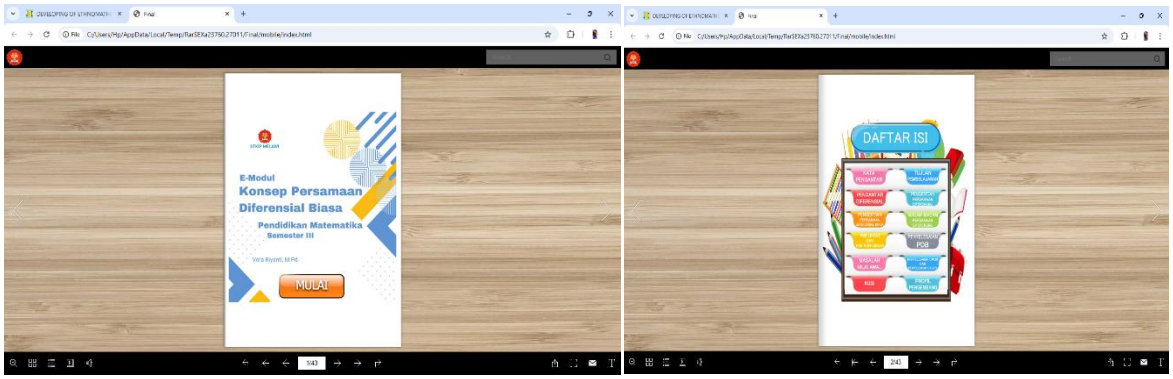

Figure 2. E-Learning Module Cover and Table of Contents

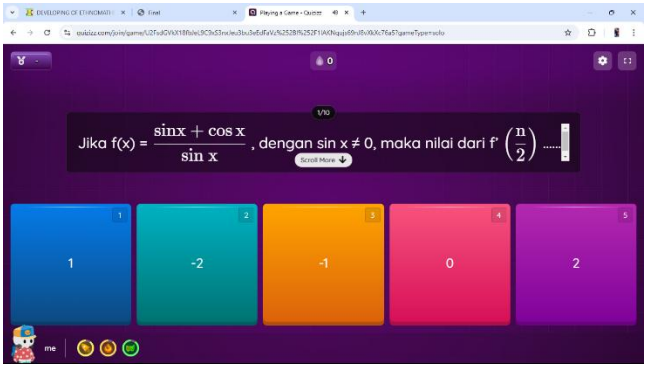

Figure 3. Quiz Questions in the E-Learning Module

Instruments designed in the design stage are then arranged according to the previously created blueprint. The assessment instruments for content, media, and student response questionnaires are validated to ensure their validity for use in research. The validators for the media assessment instruments are Mr. Fransisco Adam, M.Pd., and Mr. Vikram Yuda Octa Firandhi, M.Pd. After validation, suggestions for the e-learning module include improving the ease of page navigation, ensuring that the layout is consistent, and using appropriate color schemes that are not excessive. The content validation was conducted by Mrs. Puji Rahmawati, M.Pd., and Mr. Amin Mustajab, M.Pd., who suggested adding real-life examples to help students understand the benefits and applications of learning the concept of ordinary differential equations.

Validation from both media and content experts aims to determine whether the created e-learning module is suitable for use by learners, along with receiving feedback and suggestions for improvements. The results of the e-learning module validation are as follows.

Table 3. E-Learning Module Validation Results by 2 Subject Matter Expert

No	Assessment Aspect	Average Score for Each Aspect	Category
1	Content	3,54	Excellent
2	Language	3,66	Excellent
3	Presentation	3,62	Excellent
Overall Average Assesment Score		**3,61**	**Excellent**

The assessment of the e-learning module conducted by subject matter experts on the content of the e-learning module resulted in an overall average score of 3.61 out of a maximum score of 4.00, categorized as excellent. Validation by media experts covered aspects such as screen design appearance, ease of use, consistency, functionality, and graphic design. The results of the e-learning module validation by two media experts are shown in the following table.

Table 4. Resuts of E-learning Module Validation by 2 Media Expert

No	Assessment Aspect	Average Score for Each Aspect	Category
1	Screen Design Display	3,71	Excellent
2	Ease of Use	3,07	Excellent
3	Consistency	3,66	Excellent
4	Usefulness	3,25	Excellent
5	Graphical Quality	3,4	Excellent
Overall Average Assesment Score		**3,42**	**Excellent**

The evaluation of the e-learning module conducted by media experts resulted in an overall average score of 3.42 out of a maximum score of 4.00, categorizing it as very good. In general, the e-learning module is well-developed and suitable for use in the learning process during the implementation phase.

3.1.4. Implementation

After the e-learning module was validated by experts and revised, it was tested on 10 third-semester students from the Mathematics Education Program. The results of this trial served as a reference for further improvements to the developed e-learning module. Students, as users and respondents, provided feedback on the e-learning module concerning the concept of ordinary differential equations in the Ordinary Differential Equations course based on aspects such as content presentation, language quality, usefulness, and graphics. Students were given an explanation of the learning objectives, introduced to the game included in the e-learning module, and provided with material explanations. At the end of the material, a quiz was administered to assess students' problem-solving abilities regarding the concept of ordinary differential equations. After completing the quiz at the end of the lesson, students filled out a response questionnaire regarding the e-learning module they had used. The results of the feedback on the e-learning module can be seen in the following table.

Table 5. Resuts of Studet Responses to the E-Learning Module

No	Assessment Aspect	Average Score for Each Aspect	Category
1	Presentation of Material	3,64	Excellent
2	Language Use	3,80	Excellent
3	Usefulness	3,95	Excellent
4	Graphics	3,88	Excellent
Overall Average Assesment Score		**3,81**	**Excellent**

The evaluation of student responses to the use of the e-learning module on Ordinary Differential Equations resulted in an overall average score of 3.81 out of a maximum score of 4.00, placing it in the "very good" category. Overall, the e-learning module can be effectively used in learning, and it is expected that students will find it easier to understand the concept of ordinary differential equations and learn more independently since the e-learning module is easily accessible and practical. To assess students' problem-solving abilities in addressing issues related to the concept of ordinary differential equations, a quiz included in the e-learning module was administered. The results of the quiz can be seen in the following table.

Table 6. Results of Students' Problem-Solving Abilities

No	Student Name	Score
1	AJY	87
2	DN	91
3	EL	90
4	GG	62
5	HH	83
6	IU	70
7	MLM	61
8	MT	88
9	SW	85
10	TPM	72
Average Score		**78,9**

Based on the results of the problem-solving assessment in the quiz within the e-learning module, the average score obtained is 78.9, indicating an improvement in students' problem-solving skills by 19.1 from the initial problem-solving ability of 59.8. Analyzing the students' responses in solving problems related to the concept of ordinary differential equations, for the first indicator of problem-solving ability, the majority of students were able to identify the adequacy of data needed to solve problems, which falls into the very good category. In the second indicator, when creating a mathematical model from a problem and solving it, the performance is categorized as good. For the third indicator, which involves selecting and applying strategies to solve problems, the category is also good. Lastly, for the indicator of checking the accuracy of the results or answers, it is categorized as sufficient.

The implementation of the e-learning module on the concept of ordinary differential equations in the ordinary differential equations course for the third semester of the Mathematics Education Program took place on October 1, 2024. Documentation photos related to the implementation of this learning can be seen in the following images.

Figure 4. Implementation of the E-Learning Module

3.1.5. Evaluation

After going through the previous stages, the development of the e-learning module received several improvements based on the assessments from material experts, media experts, and student responses to the e-learning module. The results of the improvements, according to the provided suggestions, are shown in Table 7.

Table 7. Suggestions and Follow-Up

No	Suggestion	Follow-Up
1	It is necessary to include examples of the application of the material in real life so that students can understand the benefits and uses of learning the concepts of ordinary differential equations.	Examples of real-life applications of the material have been added and placed in the learning objectives section.
2	The e-learning module page navigation has been simplified to easily access specific material pages.	The pages in the e-learning module have been arranged to make it easier to navigate to the desired page.
3	The layout arrangement must be consistent to align with the sequence of the material in the table of contents.	The layout arrangement has been adjusted to match the order of the table of contents.
4	The use of colors in the e-learning module must be appropriate and not excessive to ensure ease of reading and understanding the material.	The use of colors in the e-learning module has been adjusted to avoid excess, making it easier to read and understand for users.

3.2. Discussion

Based on the research findings, a product in the form of an E-learning Module on the concept of Ordinary Differential Equations was developed. The data analysis is detailed in the following discussion.

3.2.1. Data Analysis of Subject Matter Experts and Media Experts

The analysis of the e-learning module evaluation from two subject matter experts, who are lecturers, resulted in an overall average score of 3.61, categorized as "very good." This average score indicates that the content within the developed e-learning module meets the eligibility criteria for instructional material, aligned with the learning outcomes (CPL) and course learning outcomes (CPMK) for the Ordinary Differential Equations course. Furthermore, the analysis of the e-learning module evaluation from two media experts, who are also lecturers, yielded an overall average score of 3.42, categorized as "very good." This score reflects that the e-learning module developed as a learning medium fulfills the criteria for being a suitable learning resource for both students and lecturers. The evaluations of both the content and media show excellent results, with improvements made based on the suggestions or feedback provided by the subject matter and media experts.

3.2.2. Analysis of Student Response Data

In addition to being validated by experts, the e-learning module on Ordinary Differential Equations was also implemented in the learning activities of the Ordinary Differential Equations course. The feasibility of the e-learning module was tested with 10 third-semester students from the Mathematics Education Study Program at STKIP Melawi. The results of the feasibility test indicated that the e-learning module on Ordinary Differential Equations is suitable as a teaching resource in the learning process. The average overall score obtained from student assessments was 3.81, which falls into the "very good" category. Most students, as users of the e-learning module, showed greater interest in learning with it; they felt challenged to engage in the games and complete the quizzes included in the e-learning module. With the availability of the e-learning module, students could learn more independently as it is easy and practical to use.

Based on the discussion above, the results of the feasibility study of the e-learning module on Ordinary Differential Equations, evaluated by subject matter experts, media experts, and student responses to its use, fall into the "very good" category. It can be concluded that the e-learning module on Ordinary Differential Equations is appropriate for use as a learning medium in the Ordinary Differential Equations course, and it is expected to facilitate more practical learning for students in understanding the material and to aid students in studying independently.

3.2.3. Analysis of Students Problem Solving Ability Test Data

The analysis of the problem-solving ability test data was conducted by comparing students' initial problem-solving skills during the learning process before using the e-learning module with their problem-solving abilities after utilizing the e-learning module on the concept of ordinary differential equations. The average score for students' problem-solving skills before using the e-module was 59.8, which falls into the insufficient category, particularly concerning the indicators for creating mathematical models from a problem and solving them, as well as for selecting and applying strategies to resolve mathematical issues. In tackling problems related to the concept of ordinary differential equations, most students struggled to create mathematical models and incorrectly applied strategies, which often led to incorrect conclusions or answers. The solution to the problem-solving quiz completed by the students can be seen in the following image.

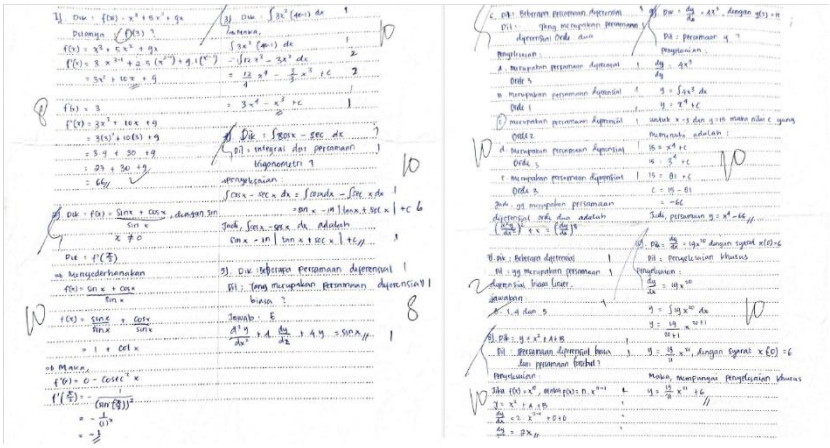

Figure 5. Answers to the Problem-Solving Skills Quiz

The analysis of the quiz results, consisting of problem-solving ability test questions given to students at the end of the learning process, yielded an average score of 78.9. Evaluating each indicator of problem-solving ability, the first indicator—identifying the adequacy of data for problem-solving—was categorized as very good, indicating that students were able to comprehend what was known and what was being asked in the questions. The second indicator, which involves creating mathematical models from problems and solving them, was classified as good, with most students demonstrating the ability to create mathematical models from the questions. (Hobri et al., 2020)The third indicator—selecting and applying strategies to solve mathematical problems—was categorized as sufficient, suggesting that while students were reasonably capable of implementing strategies to solve problems, they were sometimes inaccurate in their understanding of the chosen strategies, such as making calculation and operational errors. The fourth indicator, which involves checking the accuracy of results or answers, was categorized as sufficient as well; students were not diligent in reviewing the problem-solving process from start to finish, leading to errors in concluding the final answer.

Based on the average scores for problem-solving ability before and after using the e-learning module in the concept of ordinary differential equations, there was an increase of 19.1 points. This indicates an improvement in students' problem-solving abilities in the context of ordinary differential equations through the use of the developed learning e-learning module.

4. CONCLUSION

The development of this e-learning-based mathematics learning module takes the form of an e-learning module on the concept of ordinary differential equations. The e-learning module on the concept of ordinary differential equations was developed using the ADDIE development model, which includes Analysis, Design, Development, Implementation, and Evaluation. Based on the research findings and discussions, it can be concluded that the e-learning module on the concept of ordinary differential equations is suitable for use in learning. This e-learning module facilitates students in accessing learning resources, allowing them to become more independent and challenged in their studies. The e-learning module includes video examples of problem-solving, games, and quizzes, and it enhances students' problem-solving abilities in the context of ordinary differential equations.

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