# Development Of an Electronic Module for Antidiabetic Testing Techniques as A Guide for Pharmacy Students in Pharmacology Practicum and Research

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**Abstract:** The era of the 4.0 revolution is a time characterized by the development of information technology. This era offers opportunities for digitalization in various fields, including higher education. One area that greatly requires information technology is research, particularly in the development of electronic modules as learning media. This study aims to develop an electronic module on antidiabetic testing techniques as a guide for practice and research. The research method used is a Research and Development design, utilizing the ADDIE approach model (Analysis, Design, Development, Implementation, and Evaluation). The module used was validated by two content and language experts, two media expert validators, and validated for feasibility by 128 respondents using a questionnaire instrument, and the effectiveness evaluation of the module was tested by 36 students from the Pharmacy Department of Tadulako University. The research results show that the validity test by two content experts rated it as feasible with an average score of 4 and a percentage of 80%, the language expert rated it as very feasible with a percentage of 88.0% and an average score of 4.4, the design expert rated it as very feasible with a percentage of 92.22% and an average score of 4.6, the feasibility assessment by students rated it as very feasible to be used as learning media with an average score of 4.05 and a percentage of 81.02%, and the effectiveness test using N-Gain was 89%. This electronic module establishes a framework for developing interactive instructional materials in scientific education, particularly relevant to pharmaceutical sciences and healthcare fields, through its systematic integration of practical simulations and pharmacological research components within the learning environment.

**Keywords:** Anti-diabetes; Development; Electronic module; Practice; Research guide.

## Introduction

Technology plays a crucial role in facilitating the fulfillment of human needs. The era of the Industrial Revolution 4.0 offers opportunities for digitalization in various fields, including education; technological developments have encompassed various aspects of life, including in education (Faisal Tamimi & Siti Munawaroh, 2024). The role of education is vital in enhancing the potential of humans in a country (Bagus Cahyanto, 2020). One way to improve the development of quality human resources in the context of education is through the enhancement and development of the learning process at all levels of education. The learning process is considered a very critical aspect in the context of education. There are several components that

influence the occurrence of the learning process, namely learners, educators, teaching resources/materials, media, methods, and learning models (Dolong, 2016)(Dinatha & Kua, 2019). The development of one of the learning components, such as the development of teaching materials, is recommended to be carried out by educators to make learning more effective, efficient, and in line with the competencies that are intended to be achieved. One type of teaching material that can be used to support the learning process is modules (Marto, 2020). This digitalization can be utilized to develop innovations in teaching materials to make them more practical and attractive. One form of such development is by transforming printed teaching materials into e-modules, that is, electronic modules (e-modules). (Sihotang, 2025).

E-modules are self-learning materials that are systematically organized and presented in electronic format. This e-module is equipped with various audio or visual information tools, such as videos, animations, and audio, aimed at enriching the self-learning process (A R Najihah*, 2018; D. Handayani & Alperi, 2021; Limatahu et al., 2017; Limatahu et al., 2017).

By using e-modules, learning materials can be accessed electronically through digital devices such as computers, tablets, or smartphones. This provides flexibility and ease for students as learners to study anywhere and anytime. In addition, e-modules can also be developed with interactive features such as videos, animations, and audio to enhance the appeal and engagement of learners in the learning process. (Yerimadesi et al., 2023).

The application of e-modules in learning allows educators to provide teaching materials that are more practical, dynamic, and responsive to students' needs. Thus, the use of e-modules can make a significant contribution to achieving higher efficiency and effectiveness in the learning process (Waliulu & Palembang, 2022).

The importance of variation in delivering information, both through verbal and non-verbal communication, has proven to help students understand the learning material and improve their learning outcomes (Khaira, Ulfa, 2021); (Isnaeni & Agustina, 2018). In this way, students can become more actively involved in the learning process and have the opportunity to deepen their understanding through the use of various types of media and relevant content.

The use of e-modules in learning has a significant contribution to enhancing students' science skills. Compared to methods in conventional learning, e-modules have proven to be more effective in enhancing students' learning motivation. Additionally, the use of e-modules also provides practical advantages in the implementation of classroom learning and supports students' independence (Isnaeni & Agustina, 2018). This indicates that e-modules can be an effective and efficient tool for improving learning as well as facilitating students to learn independently.

Practical work and pharmacological research play an important role in the pharmacy education curriculum as a form of learning (Sari, 2021), where students must be directly equipped to conduct practical work and research related to antidiabetic drugs. However, they often face obstacles in developing an adequate understanding of the testing techniques used in the evaluation of antidiabetic drugs. Therefore, the development of electronic modules based on antidiabetic testing techniques as a guide for pharmacy students in practical work and pharmacological research becomes very important (Ipa et al., 2021). This module will provide a comprehensive understanding of the testing techniques used in pharmacological research related to diabetes and provide practical guidance for conducting accurate and valid tests (Dhina et al., 2019). This electronic module is expected to provide pharmacy students with an accessible and practical means to master antidiabetic testing techniques. It will facilitate their comprehension of fundamental concepts, testing procedures, and relevant data interpretation. Furthermore, the implementation of this module can enhance students' practical skills in conducting antidiabetic testing with precision and accuracy.

Therefore, this study aims to develop an effective and interactive electronic module on antidiabetic testing techniques as a learning resource for pharmacy students, with the objective of creating an interactive electronic module that can be integrated into practical laboratory training and serve as a guide for antidiabetic pharmacology research

## Method

This research design uses a type of research and development, employing the ADDIE design model (Analysis, Design, Development, Implementation, and Evaluation) (Branch, 2009); (Nisrina et al., 2025). The E-Module was developed using the Canva Flipbook application (Mahendri et al., 2023) to create an interactive and user-friendly learning module. The research was conducted from April to July 2025 at Tadulako University, located at Jalan Sukarno-Hatta KM 09, Tondo, Palu, Central Sulawesi. The study involved 36 research subjects, consisting of fifth-semester pharmacy students aged 19-21 years. The research protocol received formal approval from both the participants and the Head of the Pharmacy Study Program, Faculty of Mathematics and Natural Sciences,

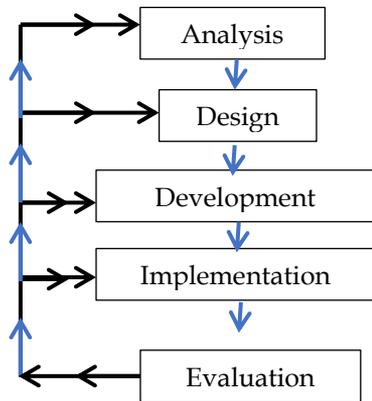Tadulako University. The procedural stages were implemented as follows:



**Figure 1.** Addie Model Development Stage, as cited in (Molenda, 2003)(F. Handayani et al., 2023)

*Analysis Stage*

The main activity at this stage is to conduct a needs analysis for product development. In this case, it is necessary to collect information and identify so that the developed product can meet the needs of students, learning objectives, learning materials, and learning environments. Observations are also conducted to obtain information about the condition of the study program, needs of the lecturers, and needs of the students related to learning materials that can be used as learning resources (Rosmiati, 2019). This analysis is carried out through the collection of information and identification to create a product to be developed according to the needs assessed from the results of observations and interviews, which include the analysis of the curriculum used, lesson plans, conditions of learning activities, and the use of teaching materials, thus obtaining an overview of product development that is tailored to the conditions and needs. A product feasibility measurement tool in the form of an assessment instrument is also needed.

*Design Stage*

In the design phase, a detailed product concept design is carried out. This activity begins with establishing specific learning objectives, designing learning activities that support those objectives, and compiling relevant learning materials. Additionally, evaluation of learning outcomes is also designed in this phase. The designs created at this stage are still conceptual and will serve as a foundation for further development. Besides learning design, the design phase also involves creating instruments for measuring the feasibility of the developed products, such as validity assessment sheets and student responses. These

instruments will be used to collect necessary data for the product feasibility evaluation process (Anafi et al., 2021).

*Development Stage*

Development is the stage where the design of the product and assessment instruments are implemented. The product design that was prepared in the planning stage is realized into a product ready for use, while the assessment instruments are also developed to measure the performance of the product. The developer checks the developed product to ensure that all components function properly and meet expectations. Next, the developed product is consulted with expert lecturers and teachers to assess its feasibility before being tested on users or targets. During the consultation process, suggestions and feedback are obtained from expert lecturers and teachers to improve the developed product. Product revisions are made based on the suggestions and feedback provided. Additionally, at this stage, the feasibility of the assessment instruments is also evaluated by experts. The assessment instruments must first be validated by lecturers to be validly used in assessing the feasibility of the product.

*Implementation Stage*

In the implementation stage, the developed product is tested in real-life classroom situations. This is done to evaluate the feasibility of the module when used directly by the users, namely the students. During the implementation, user responses to the learning module are also observed and measured. In the implementation stage, the e-module, which has been deemed feasible by experts, will be tested with students during classroom learning activities. Furthermore, students will assess the feasibility of the e-module when used as a learning tool and provide feedback on its use. The assessment and responses from the students will serve as important feedback in the evaluation stage (Anafi et al., 2021). The results of the assessments and student responses will be followed up on in the evaluation stage to see how well the e-module meets user needs and whether any improvements need to be made. The implementation stage becomes an important moment to assess the effectiveness and efficiency of the developed product before moving on to the evaluation stage.

*Evaluation Stage*

The evaluation stage is the stage where the achievement of product development goals is assessed. In addition, during this stage, product revisions are made based on the evaluation results or unmet needs. The evaluation results are obtained through assessment sheets conducted by lecturers the course of Experimental Pharmacology and the questionnaire response from students towards the e-module (Anafi et al., 2021).

In the evaluation stage, the implemented product will be assessed to see to what extent the goals of product development are achieved. Evaluation data is obtained through assessment sheets filled out by lecturers of the Experimental Pharmacology course who have the related expertise and knowledge. Additionally, student feedback questionnaires are also used to gather information on how the e-module is perceived by users, namely students. The evaluation results will serve as a reference for revising the developed product. Revisions are made to address shortcomings or weaknesses identified during the evaluation, so that the product can better meet the needs and expectations of users. By conducting a comprehensive evaluation and considering feedback from both lecturers and students, it is hoped that the developed product can be continuously improved and its quality enhanced.

*Data Analysis*

The data analysis method used in this research is descriptive data analysis. The data analyzed includes an evaluation of the feasibility of the e-module based on the results of questionnaires filled out by media experts, material experts, and student responses to the e-module. The evaluation data obtained from the questionnaire was initially in qualitative form but was then converted into quantitative data using a Likert scale. Responses in the questionnaire were converted into scores based on the weighting levels with a measurement scale of 5, 4, 3, 2, 1. After conversion, the assessment scores obtained were averaged and then converted into four categorical scales of feasibility with percentage values.

**Table 1.** Validation Benchmark of the Expert Team using the Likert Scale

| Score | Criteria |
|---|---|
| 1 | Very unworthy |
| 2 | Not worthy |
| 3 | Quite Worthy |
| 4 | Worthy |
| 5 | Very worthy |

**Table 2**. Expert Validation Score Interpretation using Likert Scale

| Percentage | Interpretation Criteria |
|---|---|
| 0 – 20 % | Very unworthy |
| 21 – 40 % | Not worthy |
| 41 – 60 % | Quite Worthy |
| 61 – 80 % | Worthy |
| 81 – 100 % | Very worthy |

To determine the effectiveness level of the module, it is analyzed with pre- and post-test using the N-gain formula proposed by Meltzer in 2002 as follows:

$$(g) = (\text{Score post test} - \text{score pree test})/(100 - \text{score pree test})$$

From the results, it is categorized based on the table below:

**Table 3.** N-Gain Categories

| Categori | Nilai N-Gain |
|---|---|
| High | $(g) \geq 0,70$ |
| Currently | $30 \leq (g) \leq 0,70$ |
| Low | $(g) < 0,30$ |

The interpretation of the effectiveness of the module based on the N-Gain category according to Arikunto is as follows.

**Table 4.** Effectiveness categories of the module according to Arikunto, 1999

| Persentage (%) | Estimate |
|---|---|
| < 40 | Not effective |
| 40 – 55 | Less effective |
| 56 – 75 | Quite effective |
| >76 | Effective |

## Result and Discussion

In this study, an electronic module product was produced for the Experimental Pharmacology course, tailored to the Semester Learning Plan (RPS) and course description in the Bachelor of Pharmacy Program, Pharmacy Department, Faculty of Mathematics, Tadulako University. The developed electronic module focuses on anti-diabetes testing techniques in animal models, implemented through self-learning guides, in-depth explanations of anti-diabetes theory, and materials explaining anti-diabetes testing techniques in animal models. This electronic module is created in the form of a flipbook using the Canva application. Digital flipbooks demonstrate significant advantages over conventional printed modules in the context of modern education. In terms of interactivity and user experience, flipbooks enable comprehensive integration of multimedia elements—including demonstration videos, conceptual animations, and audio explanations—that substantially enrich the learning experience. Regarding accessibility, this digital platform offers flexible access through various electronic devices without geographical or temporal constraints, unlike printed modules that face physical distribution limitations. The content currency aspect of flipbooks allows for real-time material updates with minimal costs, whereas printed modules require inefficient reprinting processes. Embedded learning technology features such as keyword search functions, digital bookmarking, and interactive hyperlinks provide more intuitive navigation compared to the manual indexing

systems of conventional modules. From a sustainability perspective, flipbooks offer an eco-friendly solution by reducing paper consumption and physical distribution costs. Recent research by Mahendri et al. (2023) confirms that flipbook implementation can increase learning motivation by up to 30% and enhance long-term memory retention through integrated visual-auditory stimulation, while simultaneously supporting compatibility with Learning Management Systems (LMS) that represent the standard in modern education. The concept promoted in this electronic module is a combination of learning media and learning methods. The development of this electronic module is based on a scientific approach using the ADDIE development model (*Analysis, Design, Development, Implementation, Evaluation*).

The results of the developed e-module that has been designed can be found in Figure 1. The e-module that has been created was then evaluated by two expert validators, materials, language experts, two media expert validators, and feasibility validation by students using a questionnaire instrument that includes aspects of appearance, content, grammar, and the e-module evaluation system.



**Figure 2**. The Results of the Electronic Design of Learning Modules for Antidiabetic Testing Techniques

To assess the feasibility of the product in terms of content feasibility, presentation feasibility, and graphic feasibility, validation by subject matter experts has been conducted. The module development process has undergone revisions in order to produce a final product with an average score of 4 and a percentage of 80%, categorized as feasible. The module development has adjusted the depth of the material in line with the Semester Learning Plan (RPS). In terms of content, this module is relevant to the Experimental Pharmacology material taught in the pharmacy study program at universities. This aligns with research (Auliany et al., 2024) that digital modules are effective and suitable for independent learning.

The feasibility test of the module by students was conducted using a questionnaire instrument to obtain responses and suggestions from users regarding the use of electronic learning modules. User testing was carried out to assess product criteria in terms of content

relevance, practicality, attractiveness, readability, and ease of accessing this module. User testing was conducted in a classical manner within a large group consisting of 128 students from the Bachelor of Pharmacy Study Program at the Pharmacy Department of Tadulako University, the course on Experimental Pharmacology. This module can be accepted by students with a category of very suitable for use as a learning medium, with an average score of 4.05 and a percentage of 81.02%. The results of the user test can be seen in Table 1. Respondents also stated that this electronic module is easier to learn due to the more systematic, concise, and compact design of the material presentation. This is one of the important criteria in the preparation of teaching materials.

**Table 1.** Results of the Module Feasibility Test

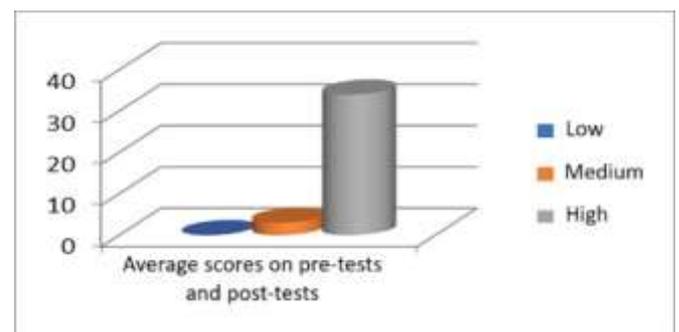| Explanation | Average Criteria Score | | (%) | Interpretation Criteria |
|---|---|---|---|---|
| | X | X1 | | |
| Qualification of filling | 4.00 | 5 | 80.00 | Worthy |
| Presentation Qualification | 4.05 | 5 | 81.02 | Very Worty |
| Language Proficiency | 4.40 | 5 | 88.00 | Very Worty |
| Design Feasibility | 4.61 | 5 | 92.22 | Very Worty |
| Average | 4.27 | 5 | 85.24 | Very Worty |



**Figure 1**. Results of the Evaluation of the Effectiveness of the e-module pretest and posttest on respondents

Language feasibility testing is conducted to ensure the use of language that is easy to read, clarity of information delivery, material presentation that is easy to understand, adherence to writing and language rules, and correct punctuation usage. The results indicate a very feasible category with a percentage of 88.0% on an average score of 4.4. According to design experts, this module can be used by students because its writing meets the standards for teaching material, with a very appropriate category scoring 92.22% with an average score of 4.6. This module is designed to be as attractive as possible with a more systematic, concise, and compact presentation of the material using audiovisuals such as animated images and videos. This is one of the important criteria in the preparation of teaching

materials so that students can better represent and recall information.

**Table 2.** Results of the effectiveness test of the electronic module N-Gain method.

| Data Source | N | Average | | Gain | N-Gain | % N-Gain | Category |
|---|---|---|---|---|---|---|---|
| | | Pree test | Post test | | | | |
| Test Results of Learning | 36 | 42.91 | 93.86 | 50.95 | 0.89 | 89% | High |

The evaluation results from 36 respondents revealed a very low initial knowledge profile regarding antidiabetic testing techniques. A total of 34 respondents (91.9%) scored in the low category on the pre-test, while only 3 respondents (8.1%) were in the medium category, and none of the respondents achieved the high category. These findings are consistent with the characteristics of practical learning, where students are often not exposed in detail to specific procedures before entering the laboratory (Çimer, 2012). This condition indicates a significant gap in understanding before the intervention is conducted.

The implementation of the e-module results in a dramatic transformation of learning outcomes. At the post-test stage, all respondents (100%) managed to achieve scores in the high category. This finding is consistent with the research by (Purnama et al., 2021), which reported that flipbook-based e-modules significantly improve cognitive learning outcomes, with the highest increase observed in groups of students with low initial abilities. This indicates that the e-modules are not only effective in statistically improving scores, but also play a role in bringing all learners to the expected level of competency mastery.

This change is clearly quantified by an N-Gain value of 89%, which falls into the high effectiveness category (Laurens et al., 2021)(G Gunawan, 2019) This value reflects the success of the e-module in closing the knowledge gap that previously existed. The majority of respondents (34 people) who had a low knowledge base experienced a substantial increase in fundamental understanding, indicating that the e-module is particularly suitable for participants with that minimal background understanding.

On the other hand, the e-module also proved relevant for respondents with moderate initial abilities, who also showed an improvement to a high category. This indicates that the designed e-module is capable of facilitating various levels of students' initial abilities while also providing added value for those who already have a foundational knowledge. (Siregar & Harahap, 2020) Also concluded that interactive e-modules can facilitate differentiated learning to enhance student learning outcomes.

The significant increase in understanding among the low initial group proves that the e-module can function as a self-directed learning tool for students, enabling them to build knowledge independently without fully relying on the instructor's explanation, which is an indicator of the success of self-learning materials (e-modules) (Zulfi Idayanti & Muh. Asharif Suleman, 2024).

In the context of the practicum, this finding has important practical implications. The e-module successfully addresses the classic problem of low theoretical understanding prior to the practicum execution. With adequate theoretical understanding guaranteed, laboratory activities can proceed more safely, efficiently, and focus on the development of analytical skills rather than merely procedural ones, in virtual pharmacy laboratories.

Based on this, it can be concluded that the e-module on Antidiabetic Testing Techniques is not only effective but also egalitarian and inclusive. Its success in guiding all students—regardless of their initial knowledge background—towards the targeted competency achievements makes it a highly worthy candidate for widespread adoption in the pharmacology practical curriculum.

## Conclusion

The electronic testing module for antidiabetes techniques is a guide for pharmacy students in the Experimental Pharmacology practice developed with information technology, containing teaching materials, practical videos, and evaluation questions compiled into a module that is integrated into one electronic platform used for both online and offline learning processes. The feasibility assessment results by students categorized the electronic module as very worthy, with a percentage of 85.24%. This e-module framework demonstrates adaptability for implementation across various scientific, pharmaceutical, and health science practicum courses to enhance students' self-directed learning competencies and conceptual mastery.

opportunity to continue their doctoral education and for the support received during this time.

**Author Contributions**
Author 1 is responsible for formulating the research idea, conducting field experiments, collecting and analyzing data, and drafting the initial manuscript, as well as being responsible for the final editing, validating the scientific content, and coordinating team communication. Author 2 contributed to the literature review, writing the introduction, and refining the manuscript structure. Author 3 contributed to language revisions, formatting according to APA reference style, and compiling the reference list. Author 4 assisted in the methodology section and processing research results. All authors have read and approved the final version of the manuscript for publication.

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The authors state that there are no potential financial, professional, or personal conflicts of interest that could affect the objectivity, validity, or interpretation of the research findings."

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