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Development of an Interactive HOTS Gamified e-Module for Prospective Elementary School Teachers at the University Level

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ABSTRACT

Background. The crritical thinking and creativity designing has not been applied and adopted in learning optimally. The HOTS e-modul learning for teacher training program will lead them to analize and maximize their learning achivment. The purpose of learning need to be improved as well as the conventional media design must be updated to help learners to teach creatively and hink critically.
Purpose. The purpose of this study is to develop HOTS content in the science subject e-module of Pohuwato University, increase creativity in developing teaching strategies and methods, improve critical thinking in understanding learning content and develop the creativity of prospective teachers in designing materials, media and teaching modules that are in accordance with the conditions and abilities of students at the elementary school level.
Method. The method used is R&D with the DDDE (Decide, Design, Develop, and Evaluate) model which was chosen because it is in accordance with the purpose of developing HOTS-based interactive e-modules and gamification. The small-scale trial of the HOTS E-module was carried out by experts of teacher, lecturers and also a large-scale trial was carried out by 46 students. The test subject was determined using the purposive sampling technique. In collecting research data, it is carried out by providing questionnaire tests that have been collected descriptively.
Results. Results shows that the interactive HOTS e-module based on gamification, developed using the DDD-E model, meets the validity criteria with an average score of 3.89, is deemed practical with an average score of 3.66, and demonstrates effectiveness, with 86.8% of students achieving a minimum test score of 70.
Conclusion. The interactive HOTS e-module, developed using the DDD-E model, is valid, practical, and effective. It equips future teachers with innovative tools to enhance critical thinking and student engagement, promoting better learning outcomes through gamified educational experiences.

KEYWORDS

HOTS e-Modul, Interactive Learning, Learning with Gamification.

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INTRODUCTION

Natural Science Learning (IPA) plays a vital role in the training of prospective elementary school teachers. Beyond providing foundational knowledge of scientific concepts, it equips future educators with critical thinking, problem-solving, and analytical skills—abilities that are essential for conveying science to young learners in ways that are engaging and easy to understand.

As elementary teachers are often responsible for sparking curiosity and a love for learning in children, it is crucial that they are well-prepared to make science relevant and stimulating (Guerrero-Alcedo et al., 2022; Purnama et al., 2023). This approach not only fosters cognitive development but also sets the foundation for future academic success in more complex fields of study. The primary aim of this research is to develop a Higher-Order Thinking Skills (HOTS) (Maxnun et al., 2024) e-module that incorporates gamification and interactive media, specifically designed for prospective teachers at Pohuwato University. The e-module focuses on enhancing critical thinking and creativity, particularly in the Science Learning Development course.

Current instructional methods often fail to engage students fully, relying on outdated tools (Lestari et al., 2024) that do not promote the dynamic skills needed for modern. This research seeks to address this gap by creating innovative resources that better prepare students to meet the challenges of teaching in a (Paris et al., 2023) digital era. One of the major challenges faced by PGSD (Elementary School Teacher Education) students is the reliance on traditional, static learning tools such as PowerPoint presentations and printed materials. A preliminary survey of 6th-semester students revealed that 93% of them struggle to effectively use digital media in their lessons, often relying on outdated tools. This not only limits their creativity but also hinders their ability to engage elementary school students in meaningful ways (Safirah et al., 2024) as future teachers, they need to be equipped with tools (Mar'atussolichah et al., 2024; Martín-Sómer et al., 2024) that promote active learning and inspire curiosity in their students. To overcome these limitations, this study integrates modern digital tools such as Canva, Flipbook with gamification platforms like Kahoot, Quizizz, and Wardwall (Lulu Maulidah et al., 2023; Rojabi et al., 2022; Wang & Wang, 2024). These tools have been individually recognized for their ability to enhance engagement and improve learning outcomes, but little research has been done on their combined use in teacher training considering that their motivtaion in learning need to improve (Nursyaida & Hardiyanti, 2020) By integrating these platforms into a single e-module, this research aims to create a comprehensive learning resource that empowers future teachers to design interactive, engaging, and thought-provoking lessons. The research is guided by the DDD-E model (Decide, Design, Develop, Evaluate) (Belmonte et al., 2019), a structured approach to curriculum development that ensures the e-module is not only effective but also adaptable (Zulkarnain et al., 2022). This model facilitates the continuous improvement of the e-module based on feedback and performance data, ensuring its long-term relevance. The use of the DDD-E model also supports the hypothesis that the integration of multiple digital platforms will result in significant improvements in students' critical thinking (Nowlan et al., 2023; Nuryadi & Widiatmaka, 2023)and creativity, essential skills for effective science education. The need for innovation in teacher education is particularly urgent at Pohuwato University, where access to high-quality, interactive learning resources is limited (Belmonte et al., 2019; Bunari et al., 2024; Mar'atussolichah et al., 2024). Many students in the region rely on traditional teaching methods that do not fully engage young learners. By introducing an interactive e-module, this research aims to transform the way science is taught, making it more accessible and engaging for both teachers and students. Moreover, the study addresses the broader issue of how technology can be used to enhance education in regions where resources are often scarce (López-Belmonte et al., 2021). This research aligns with Indonesia's national educational goals, particularly the emphasis on 21st-century skills like critical thinking, communication, and collaboration (Kumar, 2021). By fostering these skills in prospective teachers (Alshareef et al., 2022; Bogusevschi et al., 2019; Mahmud & Law, 2022), the e-module contributes to the broader effort to modernize Indonesia's education system and prepare students for the challenges of the future (Surdyanto & Kurniawan, 2020). The integration of digital tools also supports the country's push towards incorporating technology into all levels of education, ensuring that teachers are well-equipped to meet the needs of today's digitally-savvy learners. As it said by Samad and Munir (Samad & Munir, 2022) that teachnology learning is more useful to help learners and teachers in their learnig progress.

Gamification has been widely recognized for its ability to increase student engagement and motivation (Guerrero-Alcedo et al., 2022; Mee Mee et al., 2021; Shortt et al., 2023). In this study, platforms like Quizizz and Kahoot are used to make science learning more interactive and enjoyable for prospective teachers (Pham, 2022a, 2022b). By incorporating game-based elements, the e-module not only makes learning more fun but also helps to reinforce critical thinking and problem-solving skills that in this case Lim and Yunus (Lim & Yunus, 2021; Talib et al., 2023) emphasized that the use of digital learning brings positive impacts for teachers that the technology has beneficial (Budiarto et al., 2024; Fajaruddin et al., 2024; Ritonga et al., 2024), easy of use and its feasibility are acceptable among teachers. This is particularly important for elementary science education (Bogusevschi et al., 2019), where maintaining student interest is often a challenge (Kanoksilapatham & Suranakkharin, 2021; Usman & Anwar, 2021). Creativity is an essential skill for teachers, especially when it comes to science education (Nuryadi & Widiatmaka, 2023). The ability to present scientific concepts in novel and engaging ways can make the difference between students who struggle to grasp difficult concepts and those who thrive in the classroom (Purnama et al., 2023). The e-module developed in this study encourages prospective teachers that seek to fill the gap in teacher to think creatively about how they can incorporate digital tools into their lessons, fostering an innovative approach to science education that will benefit their future students (Nurhidayat et al., 2024).

This research's primary objective is to develop the tools of e-modul in Higher Order Thinking Skills contents of science learning. By equipping future educators with the skills to use digital tools creatively and effectively, the e-module aims to raise the overall quality of science education in the region. One of the key benefits of the e-module is its ability to bridge the gap between theoretical knowledge and practical application. The implications of this research extend beyond the immediate scope of developing a HOTS e-module (Jing & Eng, 2023; Subari, 2022)for prospective elementary teachers. This study seeks to address a critical need in teacher education by developing a gamification-based e-module that enhances critical thinking and creativity. Through the integration of modern digital tools (Erdoğan, 2019; Irzawati, 2023; Sukadari et al., 2023)and interactive learning strategies, this research aims to equip future elementary school teachers with the skills they need to create engaging, innovative, and effective science lessons. By doing so, it not only improves the quality of teacher education at Pohuwato University but also contributes to the broader effort to modernize Indonesia's education system and prepare future generations for success in the 21st century.

RESEARCH METHODOLOGY

Research design

This study employed a Research and Development (R&D) approach, specifically following the Decide, Design, Develop, and Evaluate (DDD-E) model (Zulkarnain et al., 2022), to create Higher-Order Thinking Skills (HOTS)-based interactive e-modules integrated with gamification (Safirah et al., 2024).The DDD-E model was chosen as it aligns with the objective of systematically developing e-modules (Erna et al., 2021; Jing & Eng, 2023; Maxnun et al., 2024)that enhance critical thinking and creativity in prospective elementary school teachers. The approach enables a structured process to set learning goals, design the e-modules, develop the content, and evaluate their effectiveness.

Research procedure

The research utilized two key instruments: a Likert-scale questionnaire and an expert validation process. The questionnaire, administered to 46 students, measured perceptions of the e-module's usability, content relevance, engagement, and its impact on critical thinking and creativity, using a five-point scale. The expert validation involved three experts, including PGSD lecturers of social science and IT specialists as well as the teacher from Elementary school, who assessed the e-module's content accuracy, technological usability, pedagogical effectiveness, and

practicality. These combined instruments provided comprehensive insights into both the effectiveness of the e-module and its alignment with educational goals.

The procedure of this research followed by the DDD-E model, the procedures were structured into four key stages:

1. **Decide**: This stage focused on identifying the learning objectives, mapping themes relevant to the Science Learning Development course, defining problems, and conceptualizing solutions. The learning resources and prerequisite abilities were also determined here.
2. **Design**: The design stage involved creating the e-module's outline using flowcharts, display models, and storyboards. This step provided a clear framework for incorporating interactive and gamified elements.
3. **Develop**: During this stage, the e-module was created by incorporating interactive features like animations, audio, video, quizzes, and images using digital platforms such as Canva, MS PowerPoint, Flipbook, Polotno Studio, Wardwall, and Book Creator. The content was tailored to enhance critical thinking and creativity in the PGSD students.
4. **Evaluate**: The final stage involved expert validation followed by product testing with the student participants. The evaluation assessed the e-module based on **validity, practicality, and effectiveness** criteria. Feedback from both experts and students led to revisions before the final implementation of the product.

Research Subjects

The research involved a sample of 46 students from the Elementary School Teacher Education Study Program (PGSD) at Pohuwato University. These participants were 6th-semester students selected through purposive sampling to ensure they represent the target audience for the developed e-modules. The students were chosen because they are directly engaged in the Science Learning Development course and face challenges in utilizing innovative teaching strategies, which this study aims to addres.

Research Ethics

The research followed ethical guidelines by obtaining informed consent from all participants, ensuring they understood the study's purpose and their right to withdraw at any time. Participants' identities were anonymized to maintain confidentiality, and data collection was handled without coercion or bias. Expert validators were also informed of their role, and their feedback was kept confidential. The study prioritized participants' well-being and focused on improving educational practices ethically.

Data collection and Alaysis Technique

The quantitative data from the questionnaires were analyzed using descriptive statistics to measure the feasibility and impact of the e-module. Scores from the Likert scale were analyzed to evaluate students' perceptions of the module's ability to improve critical thinking and creativity. For the qualitative feedback provided by the experts, thematic analysis was applied to identify areas of improvement and confirm the validity of the module's design and content.

RESULT AND DISCUSSION

This research developed the science learning media content hots e-module with gamification and the results of its development products including:

1. **Decide**

In the **Decide** stage, the research aims to enhance the critical thinking skills and creativity of prospective elementary school teachers by developing interactive, application-based e-modules incorporating HOTS and gamification at Pohuwato University. The learning theme focuses on HOTS in science, with content designed around gamified quizzes linked to the subject material. The participants are students from the Elementary School Teacher Education program, who have prior knowledge of media learning and science. The prerequisite for the trial involves students having Android smartphones to access the HOTS e-module design.

The developed material consists of science content with HOTS questions, which is then combined with gamification through tools like Mentimeter, Quizizz, Wardwall, and Kahoot,

designed in an engaging way to boost motivation, critical thinking, and creativity so that students can develop their creativity as prospective elementary school teachers at the university level to be applied a teacher's training program at school and when they face the microteaching process that require them to create their own media learning using technology based on the material subjects they take to be learned in their classroom training.

2. **Design**

The develop material consists of science content with HOTS questions, which is then combined with gamification through tools like Mentimeter, Quizizz, Wardwall, and Kahoot, designed in an engaging way to boost motivation, critical thinking, and creativity so that students can develop their creativity as prospective elementary school teachers at the university level

3. **Develop**

The HOTS e-modul science was developed using canva and Heziein flipbook as following design:

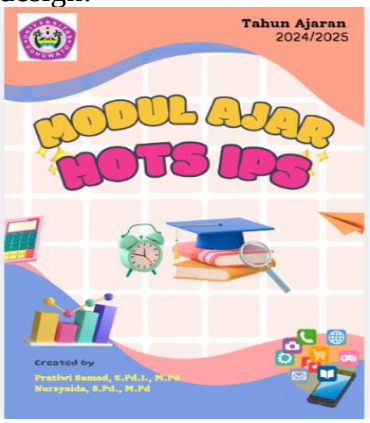

Figure 1. The cover

Figure 2. Game's instruction

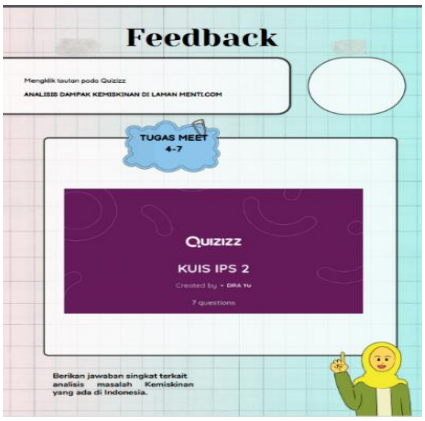

Figure 3. Quizizz gamification

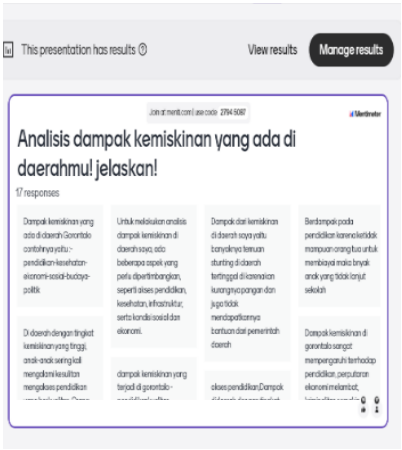

Figure 4. Students' feedback

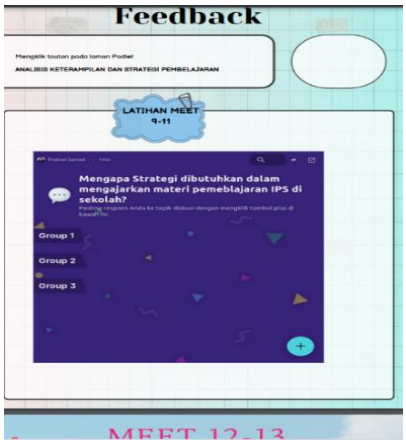

Figure 5. Task on Wardwall

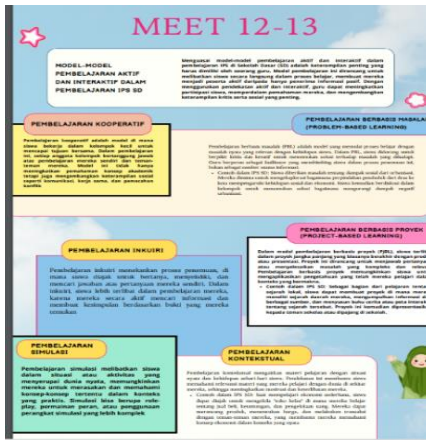

Figure 6. Topics of meet 12-13

Figure 1 shows the initial page of the HOTS e-module or the module cover, which features social studies content with HOTS questions and reading materials, along with a gamified learning link in the form of Mentimeter, as seen in Figure 2. Here, students can directly respond to the material they receive by providing statements, opinions, or conclusions related to the subject matter. Figure 3 depicts a gamified Quizizz quiz with HOTS questions on topics different from the material in the module. This is followed by Figure 4, which shows student responses on the Mentimeter page. Figures 5 represent quizzes in the form of Wardwall, with Figure 6 summarizing the HOTS material instructions for prospective elementary school teachers, focusing more on enhancing their creativity at the university level.

4. **Evaluate**

The feasibility of the HOTS e-module has been validated by 3 experts as validators, each with their own expertise: a computer expert, a media expert, and an elementary school teacher.

Table 1. Validator's assessment results

Aspects Assessed	Validator			Average	Qualification
	1	2	3		
Content of media	4	3.67	4	3.89	Valid
Language and appearance	4	3.8	4	3.93	Valid
Illustration and layout	3.75	3.67	3.75	3.72	Valid
Benefits	4	4	4	4	Very valid
Overall average score				3.89	Valid

The results of the validator test indicate that the HOTS e-module content media product based on gamification (Maxnun et al., 2024; Widiyastuti et al., 2021) that has been developed meets the valid criteria with a score of 3.89. Expert validators provided several revisions to further optimize the development of the HOTS science content based on gamification before it is declared valid, requiring the following improvements:

Table 2. Before and after revised HOST e-modul

Before revision	After revision
Difficulties to access the link of gamification	The link has been prepared to be accessable
The colour was too basic	The colors has been changed in interesting pastel colors
The quiz was mistaken at the written subejct	The written has been fixed
The content of gamified has no instruction in specific	The instruction has been linked to the gamified test

After the media was deemed valid, a trial was conducted with prospective PGSD teacher students at Pohuwato University to evaluate whether the developed product met the standards of practicality and effectiveness.

Figure 7. Socialization and trial to the students

Table 3. Students' respond of media

No	Statements	Average	Qualification
1	The initial interface of the media program is visually appealing.	3.84	Very good
2	The application features attractive colour schemes.	3.52	Very good
3	The text presented in the media is easy to read.	3.60	Very good
4	The material aligns seamlessly with HOTS science content.	3.63	Very good
5	The background music within the application is pleasant and engaging.	3.19	Good
6	The gamification elements are well-integrated with the HOTS science content.	3.76	Very good
7	The material is presented in a manner that is easy to comprehend.	3.78	Very good
8	Examples and practice questions are relevant to the HOTS science curriculum.	3.78	Very good
9	This media effectively enhances students' critical thinking and creativity.	3.80	Very good
10	The media is intuitive and user-friendly	3.65	Very good
The Overall Average Score		**3.66**	**Very good**

The overall average score from student responses was 3.66, which qualifies as "very good." At this stage, it can be concluded that the developed media meets the criteria for practicality. By following this, a learning outcome test was administered to students at the end of the lesson to assess the effectiveness of the developed learning media.

Table 4. Students' percentage of test scoring result

Test score (Nt)	Student's percenatge
Nt ≥ 70	86.8 %
Nt < 70	13.2 %

From the learning test results, 86.8% of students scored Nt ≥ 70, indicating that the developed media met the criteria for effectiveness. The interactive HOTS e-module based on gamification, developed using the DDD-E model, meets the validity criteria with an average score of 3.89, is deemed practical with an average score of 3.66, and demonstrates effectiveness, with 86.8% of students achieving a minimum test score of 70.

The development of interactive e-modules designed to enhance Higher Order Thinking Skills (HOTS), using the DDD-E model, has proven to be a significant asset for future teachers. These e-modules have demonstrated high validity, practicality, and effectiveness, as indicated by strong average scores and a majority of students achieving targeted outcomes. This discussion will explore the benefits of using these e-modules in preparing future educators, as well as the broader implications for student engagement and critical thinking development (Maxnun et al., 2024). One of the key strengths of the interactive HOTS e-module lies in its demonstrated validity and practicality. The content has been tested and refined to ensure it aligns with educational standards, while also being user-friendly for both teachers and students. Additionally, the effectiveness of the e-module is reflected in the positive learning outcomes achieved by students. This highlights the module's potential to be a reliable tool in the classroom, encouraging a more interactive and engaging learning experience.

A central goal of the HOTS e-module is to foster critical thinking skills in students. By incorporating elements of gamification, the e-module challenges learners to think more deeply and creatively as they engage with the material (Rostikawati et al., 2023). For future teachers, this module provides a practical example of how technology can be leveraged to promote higher-order

thinking. It also equips them with innovative approaches that can be applied to their own teaching practices, helping to create more stimulating and thought-provoking classroom environments. In addition to promoting critical thinking, the interactive nature of the e-module significantly increases student engagement. Gamified learning experiences capture students' attention and motivate them to participate actively in the learning process (Pratiwi et al., 2023; Shortt et al., 2023). This is crucial for future teachers to understand, as student engagement is a key component of effective teaching. The e-module serves as a valuable example of how digital tools can be used to make learning more dynamic, thereby enhancing overall student achievement. The activities vibes among students when being taught using the e -modul became more interactive and participated to ask, giving ideas, explore critical thinking to input their answers inside the gamified learning (Ricu Sidiq & Najuah, 2020). The process of participation were also seen some results of samad, paris and Rostikawati (Paris et al., 2023; Rostikawati et al., 2023; Samad & Munir, 2022).

The development of this HOTS e-module not only benefits future teachers but also opens up avenues for further research and innovation in educational practices. As more educators and researchers explore the effectiveness of the DDD-E model and gamification in learning, there is potential for even more refined and impactful teaching tools to emerge. Future teachers who incorporate such innovative strategies into their classrooms will be better equipped to meet the evolving needs of their students, promoting long-term academic success and engagement.

CONCLUSION

The interactive HOTS e-module based on gamification, developed through the DDD-E model, proves to be a valuable tool for candidate teachers. Its high validity, practicality, and effectiveness, as evidenced by the strong average scores and a majority of students achieving the targeted test results, indicate that this e-module can enhance critical thinking and engagement in learners. For future teachers, incorporating this type of innovative digital learning tool in their teaching strategies will equip them with effective methods to foster higher-order thinking skills and create engaging learning environments.

This research highlights the successful development of a HOTS-based interactive e-module for PGSD students at Pohuwato University, which is both practical and effective. The integration of the DDD-E model and gamification enhances not only the learning experience but also the ability of future educators to teach with creativity and critical thinking. This is important as it fills a gap in traditional teaching methods by offering innovative, adaptable tools that are better suited to modern educational needs. The findings demonstrate that adopting this e-module leads to more engaged, critically thinking students, ultimately improving their learning outcomes. By preparing future teachers with these advanced strategies, the study contributes to the ongoing evolution of education, ensuring that students are equipped to meet the challenges of a more complex, dynamic learning environment. This work underscores the relevance of adopting technology-enhanced, HOTS-based learning modules in teacher training, setting a precedent for broader educational reforms and emphasizing the need to continuously evolve teaching methods to foster better learning and engagement.

The interactive HOTS e-module, developed using the DDD-E model, is valid, practical, and effective. It equips future teacher and any other readers or researchers to gain the information related to DDD-E design modul HOTS with innovative tools to enhance critical thinking and student engagement, promoting better learning outcomes through gamified educational experiences.

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AUTHOR'S COTRIBUTION

Author 1: Design ideas, providing the content decision of the research development

Author 2: Analyzing, validatin, interpreting in writing description

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