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Enhancing Pgmi Students' Conceptual Understanding Through A Contextual Teaching And Learning-Based Science E-Module

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Abstract
This study aims to develop a science e-module based on Contextual Teaching and Learning (CTL) to improve the conceptual understanding of students of the PGMI Study Program of IAI Al-Khairat Pamekasan. This study uses the Research and Development (R&D) method with the ADDIE model which includes the stages of analysis, design, development, implementation, and evaluation. The subjects of the study were PGMI IAI Al-Khairat Pamekasan students taking the Science Study course in the 4th semester of 2025. Research data were collected through observation, interviews, questionnaires, and tests. The instruments used included expert validation sheets, student response questionnaires, and pretest and posttest questions. Data were analyzed using the Aiken's V index to test validity, percentage analysis to measure practicality, and N-gain to determine product effectiveness. The results showed that the developed e-module obtained an average validity of 0.87 with a very valid category. The results of the practicality test showed a percentage of 86.75% with a very practical category. The results of the effectiveness test showed an increase in students' conceptual understanding, marked by an increase in the average pretest score from 61.42 to 84.28 in the posttest, with an N-gain value of 0.59 in the moderate category. Based on these results, the CTL-based Science e-module was declared valid, practical, and effective for use in Science Studies learning. This e-module is expected to be an alternative digital teaching material that supports independent, interactive, and contextual learning for PGMI students.
Keywords: *Science E-Module, Contextual Teaching And Learning, Conceptual Understanding, PGMI, ADDIE.*

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INTRODUCTION

Improving the quality of science learning is a crucial agenda in higher education, including in the Elementary School Teacher Education (PGMI) program. Prospective elementary school teachers are required not only to master facts but also to understand scientific concepts correctly, comprehensively, and meaningfully. This urgency aligns with Indonesia's scientific literacy, which still needs strengthening. The OECD reported that in the 2022 PISA (Page 22) only 34% of Indonesian students reached Level 2 or higher in science, far below the OECD average of 76%. At this minimum level, students are only able to recognize correct scientific explanations for familiar phenomena and use simple data to assess the validity of conclusions. These findings suggest that strengthening scientific conceptual understanding needs to be carried out continuously, including from the pre-service teacher education stage (OECD, 2023).

This need is increasingly urgent because several studies have shown that prospective elementary school teachers still face limitations in their conceptual understanding of science. Al Sultan et al. (2021) found that preservice elementary teachers' scientific literacy needs to be improved to align with the demands of science education reform. On the other hand, Nadelson et al. (2018) emphasized that conceptual change is fundamental to science learning because students often carry initial conceptions or misconceptions formed from everyday experiences, superficial explanations, and non-scientific sources. In the context of PGMI students, a weak understanding of science concepts has the potential to have long-term impacts because it can carry over into their teaching practices when they later teach in Islamic elementary schools (Al Sultan et al., 2021; Nadelson et al., 2018).

This research aligns with the results of a preliminary study on PGMI IAI Al-Khairat Pamekasan students, which revealed that students' understanding of science concepts is still suboptimal. This is evident in the fact that some students still have difficulty explaining science concepts coherently and systematically, particularly when outlining the relationships between concepts and explaining natural phenomena from a scientific perspective. Students are also not yet fully able to connect science material to everyday life phenomena, so that learning tends to be oriented towards memorization and does not produce meaningful understanding. Furthermore, students' use of digital learning resources is also still limited. Some students are not yet accustomed to using digital learning materials independently and still rely on lecturers' explanations as their primary learning resource. These findings indicate the need to develop interactive and context-based digital learning materials, so that they can help students understand science concepts in a more in-depth, applicable, and relevant way to real life.

One way to address this issue is to provide digital learning materials designed for independent, interactive, and flexible learning. Asrizal et al. (2024) explain that e-modules are systematically structured learning materials that can integrate links, animations, videos, and audio, enriching the learning experience. These characteristics make e-modules potentially effective in increasing student engagement in the learning process. Empirically, the use of digital modules has also been reported to improve conceptual understanding and thinking skills, as demonstrated by Kustantia et al. (2023) and Halim et al. (2021).

However, digitalizing teaching materials alone is insufficient if the presentation remains abstract and disconnected from students' real-world experiences. In this context, the Contextual Teaching and Learning (CTL) approach is relevant because it emphasizes the connection between the material being studied and real-world situations. Taasoobshirazi and Carr (2008) explain that context-based learning places science material in real-life contexts to enhance motivation, problem-solving, and learning outcomes. Similarly, Kuhn and Müller

(2014) demonstrate that the use of real-world contexts in science education has a positive effect on motivation, achievement, and transferability. Thus, CTL not only helps students understand concepts but also encourages them to see the significance of science in everyday life.

The relevance of CTL in developing teaching materials has also been supported by several studies. Dewi and Primayana (2019) reported that modules with CTL settings resulted in a higher increase in understanding of physics concepts compared to direct learning, with *a normalized gain of* 0.71 in the CTL group and 0.43 in the direct learning group. Research by Ramadhanti and Azhar (2022) also showed that CTL-based e-modules were valid in terms of appearance, content, and language. Meanwhile, Hidayat et al. (2024) found that science e-modules with a contextual approach integrated with local wisdom were classified as highly valid, very practical, and effective as learning resources. However, these studies still focus on specific school levels and science topics, so the development of CTL-based science e-modules in higher education contexts, especially for PGMI students, still requires strengthening.

Based on this description, the development of a science e-module based on *Contextual Teaching and Learning* to improve the conceptual understanding of PGMI IAI Al-Khairat Pamekasan students is important. This development is expected to provide teaching materials that are more interactive, contextual, and in accordance with the characteristics of prospective elementary madrasah teachers, so that the science learning process does not stop at mastering memorization, but encourages the formation of a deeper and more applicable conceptual understanding (Taasoobshirazi & Carr, 2008; Dewi & Primayana, 2019; Asrizal et al., 2024).

METHOD

This study uses the Research and Development (R&D) type *with* the ADDIE model, which includes five stages, namely analysis, design, development, implementation, and evaluation. The ADDIE model was chosen because it provides systematic steps in designing, developing, implementing, and evaluating learning products so that it is suitable for use in the development of science e-modules based on *Contextual Teaching and Learning* (CTL) (Branch, 2009).

Science Study course in the 4th semester of the academic year 2025. The research subjects consisted of 4th semester students selected as product users, while the validation subjects consisted of material experts, media experts, and linguists. The number of user subjects was 35 people, while the validators consisted of 3 people. The selection of research subjects was carried out by purposive sampling/total sampling according to the needs of product development.

Analysis stage, researchers identified learning needs through initial observations, interviews, and analysis of student characteristics, particularly regarding difficulties in understanding science concepts, relating material to everyday life contexts, and utilizing digital learning resources. The design stage was carried out by compiling an e-module design, material maps, learning objectives, CTL components, research instruments, and product displays. The development stage was carried out by compiling an initial science e-module product, then the product was validated by experts to assess the feasibility of content, language, presentation, and graphics. After being revised based on validator suggestions, the product was trialed on students taking the Science Studies course. The implementation stage was carried out in limited learning to determine the practicality and effectiveness of the e-module. Furthermore, the evaluation stage was carried out formatively at each stage and

summatively at the end of implementation to assess the final quality of the product (Branch, 2009).

Data collection techniques in this study include observation, interviews, questionnaires, and tests. Observations and interviews were used in the preliminary study to obtain an overview of student needs and learning conditions. Questionnaires were used to obtain validity data from experts and student response data on the practicality of the e-module. Tests were used to measure students' conceptual understanding before and after using the e-module through pretests and posttests. The research instruments used consisted of observation sheets, interview guidelines, expert validation sheets, student response questionnaires, and conceptual understanding test questions.

The validity data of the e-module was analyzed using Aiken's V index, as this technique is commonly used to assess content validity based on expert assessments of each component of an instrument or product. Aiken's V value ranges from 0 to 1, and the closer it is to 1, the better the content validity (Aiken, 1985). Practicality data was analyzed descriptively quantitatively using the percentage of student response questionnaire scores. Meanwhile, effectiveness data was analyzed using N-gain scores from pretest and posttest results to determine the increase in students' conceptual understanding after using the e-module. N-gain analysis is widely used to see improvements in learning outcomes based on the difference between the initial and final normalized scores (Hake, 1998).

The assessment criteria in this study include: (1) the product is declared valid if the results of the expert assessment are in the valid category, (2) the product is declared practical if it receives a positive response from students, and (3) the product is declared effective if there is an increase in students' conceptual understanding based on the results of the N-gain analysis in the medium or high category. Thus, the quality of the e-module developed is reviewed from the aspects of validity, practicality, and effectiveness.

RESULTS AND DISCUSSION

Findings (can be in form of subheading)

A Contextual Teaching and Learning (CTL) based science e-module with the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The results of the study focused on three main aspects: validity, practicality, and effectiveness of the e-module in improving the conceptual understanding of students at PGMI IAI Al-Khairat Pamekasan.

1. Results of Needs Analysis

Based on a preliminary study conducted through observation and initial interviews with students of the PGMI Study Program at IAI Al-Khairat Pamekasan who are taking the Science Studies course in the 4th semester of 2025, information was obtained that students' understanding of science concepts is still not optimal. Some students still have difficulty explaining science concepts coherently, connecting concepts to everyday life phenomena, and utilizing digital learning resources independently. In addition, the teaching materials used in learning are still dominated by lecturer explanations and conventional learning resources, so students need digital teaching materials that are more interactive, systematic, and contextual.

The results of this needs analysis formed the basis for developing a CTL-based science e-module. The developed e-module is designed to include components such as material, contextual examples, illustrations, exercises, evaluations, and independent learning activities tailored to the characteristics of PGMI students.

2. Product Development Results

The product of this research is a science e-module based on *Contextual Teaching and Learning* for PGMI students in the Science Studies course. The e-module was developed in digital format that can be accessed via laptop or smartphone. The e-module structure includes an opening page, user instructions, learning outcomes, concept maps, learning materials, CTL-based activities, practice questions, evaluation, and a bibliography.

The CTL characteristics of e-modules are realized through the presentation of material linked to real-life phenomena, prompting questions, exploratory activities, and exercises that encourage students to connect science concepts to their surrounding context. Thus, e-modules serve not only as digital learning resources but also as a means to build a more meaningful understanding of concepts.

3. Product Validation Results

Before implementation, the e-module was first validated by three validators: a content expert, a media expert, and a language expert. Validation was conducted to determine the product's suitability in terms of content, presentation, language, and appearance.

The results of the material expert validation showed that the e-module obtained an average score of 0.89 with a very valid category . The material expert assessment showed that the e-module content was in accordance with the learning outcomes of the Science Study course, the material was presented systematically, and the examples used supported students' understanding of the concepts.

Media expert validation results showed an average score of 0.87 , categorized as very valid . Aspects assessed included the e-module's appearance, readability, layout, design consistency, and ease of use. Overall, the e-module was deemed attractive and easy to operate.

Furthermore, the validation results from linguists showed an average score of 0.85 , categorized as valid . The language used in the e-module was deemed communicative, in accordance with Indonesian language rules, and easily understood by students. Overall, the product validation results can be seen in Table 1.

Table 1. Validation Results of CTL-Based Science E-Module

Rated aspect	***Average Score***	***Category***
Subject matter expert	0.89	Very valid
Media expert	0.87	Very valid
Linguist	0.85	Valid
Overall average	**0.87**	**Very valid**

Based on these results, the CTL-based science e-module was declared suitable for testing after being revised in accordance with the validators' suggestions. These revisions included editorial improvements, visual enhancements, the addition of illustrations, and the reorganization of several sections of the material to make them more systematic.

4. Practicality Test Results

The product trial was conducted on 28 students of the PGMI Study Program of IAI Al-Khairat Pamekasan who were taking the Science Study course in semester 4 of 2025. The practicality of the e-module was measured through a student response questionnaire after using the product in learning. The questionnaire results showed that the e-module obtained a practicality percentage of 86.75% with a very practical category.

Students stated that the e-modules were easy to access, had attractive displays, clear instructions, and that the material presented helped them better understand science concepts. Furthermore, they found that the contextual examples in the e-modules made it easier for them to relate the material to everyday life. The practical results of the e-module are presented in Table 2.

Table 2. Results of the E-Module Practicality Test

Rated aspect	***Average Score***	***Category***
Subject matter expert	0.89	Very valid
Media expert	0.87	Very valid
Linguist	0.85	Valid
Overall average	**0.87**	**Very valid**

Based on these results, the CTL-based science e-module was declared suitable for testing after being revised in accordance with the validators' suggestions. These revisions included editorial improvements, visual enhancements, the addition of illustrations, and the reorganization of several sections of the material to make them more systematic.

5. Effectiveness Test Results

The effectiveness of the e-module was measured through *pretest* and *posttest results* to determine the increase in students' conceptual understanding after using the e-module. The analysis showed that the average *pretest score* was 61.42 , while the average *posttest score* was 84.28 . Thus, there was an increase in scores after using the e-module.

Based on the results of the N-gain calculation , an average value of 0.59 was obtained , which is in the moderate category . These results indicate that the use of CTL-based science e-modules is effective in improving students' conceptual understanding. *the pretest* , *posttest* , and N-gain results can be seen in Table 3.

Table 3. Pretest, Posttest, and N-Gain Results

Indicator	***Mark***
Pretest average	61.42
Posttest average	84.28
N-gain value	0.59
Category	**Currently**

This improvement demonstrates that the developed e-module is capable of helping students better understand science concepts. This is evident in their improved ability to explain concepts coherently, relate the material to everyday life phenomena, and answer conceptual questions after using the e-module.

Analysis

The developed Contextual Teaching and Learning (CTL) based science e-module meets the criteria of validity, practicality, and effectiveness. This finding suggests that systematically designed digital teaching materials linked to real-life contexts can be a relevant tool for improving students' conceptual understanding. Theoretically, this finding aligns with the views of Taasoobshirazi and Carr (2008) who assert that context-based learning places science materials in real-life situations, thereby enhancing motivation, problem-solving, and learning outcomes. In the context of this study, the e-module not only functions as a digital teaching material, but also as a medium that helps students connect science concepts with their everyday experiences and phenomena.

In terms of validity, the developed e-module was categorized as valid to highly valid based on assessments by material experts, media experts, and language experts. These results indicate that the product has met the eligibility criteria for content, presentation, language,

and appearance. Good validity indicates that the material in the e-module is aligned with the learning objectives, systematically structured, and presented in a format that is easily understood by students. These findings align with research by Kustantia, Miarsyah, and Sigit (2023) which demonstrated that digital modules support students' conceptual understanding and critical thinking and are considered suitable for use in learning. These results also align with research by Hidayat, Marwoto, and Widiyatmoko (2024) which found that science e-modules with a contextual approach have a very high level of validity, making them suitable for use as learning resources.

The high validity of the e-module in this study can also be explained by the product's suitability to the needs of PGMI students as prospective elementary school teachers. A preliminary study found that students still had difficulty explaining science concepts coherently, connecting them to everyday life phenomena, and utilizing digital learning resources independently. Therefore, the e-module was designed not only to present the material but also to facilitate the formation of a stronger conceptual understanding. This is important because Al Sultan, Henson, and Lickteig (2021) found that *scientific literacy understanding* among prospective elementary school teachers still needs to be improved to meet the demands of science education reform. Therefore, the product validity results in this study reinforce the idea that developing teaching materials tailored to the needs of prospective teachers is an important and relevant step.

In terms of practicality, the research results show that the e-module received a positive response from students. Students considered the e-module easy to use, engaging, accessible through digital devices, and helpful for independent learning. This high level of practicality indicates that the product developed is not only conceptually sound but also applicable in real-life learning situations. This finding aligns with research by Hidayat, Marwoto, and Widiyatmoko (2024) which demonstrated that a contextual approach-based science e-module has a very high level of practicality in learning. This practicality is likely influenced by the e-module's flexible design, clear instructions, and presentation of material that is close to students' experiences. In science learning, a context close to the user's life makes the learning process easier to understand and more meaningful (Taasoobshirazi & Carr, 2008).

Furthermore, in terms of effectiveness, the results of the study indicate an increase in students' conceptual understanding after using the CTL-based science e-module. The increase in *pretest* to *posttest scores* and *the N-gain value* in the moderate category indicate that the e-module makes a positive contribution to learning. This result is understandable because the e-module allows students to learn gradually, repeatedly, and more independently, while the CTL approach helps students connect abstract concepts with real situations. This finding is in line with the research of Dewi and Primayana (2019) who reported that modules with CTL settings were able to improve conceptual understanding better than direct learning. The results of this study are also supported by the findings of Kustantia, Miarsyah, and Sigit (2023) that the use of digital modules can improve students' conceptual understanding.

The effectiveness of e-modules in improving conceptual understanding can also be explained through the perspective of conceptual change. In science learning, students often bring prior knowledge that is not necessarily scientific, so the learning process must be able to help them revise this understanding. Research by Halim, Mahzum, Yacob, Irwandi, and Halim (2021) shows that the use of *e-learning modules can improve posttest* scores and help reduce misconceptions in physics learning. This suggests that well-designed digital learning materials can play a role in improving students' understanding. In this study, the presence of

contextual examples, exercises, and exploratory activities within e-modules likely contributed to improving students' conceptual understanding.

More specifically, the results of this study are important for PGMI students because they are being prepared to become teachers who will teach science concepts to elementary school students. This means that improving students' conceptual understanding not only impacts their current academic achievement but also has the potential to influence the quality of science teaching in elementary schools in the future. When prospective teachers have a good conceptual understanding, are able to connect material to real-world phenomena, and are accustomed to using digital learning resources, they will be better prepared to implement meaningful learning. This aligns with the findings of Al Sultan et al. (2021) that prospective elementary school teachers still need strengthening in aspects of scientific literacy and conceptual understanding.

Based on these overall findings, it can be stated that the developed CTL-based science e-module has a real contribution in supporting science study learning for PGMI IAI Al-Khairat Pamekasan students. Product validity indicates that the e-module is feasible to use, practicality indicates that the e-module is easy to apply in learning, and effectiveness indicates that the e-module is able to improve students' conceptual understanding. Thus, the results of this study strengthen the view that contextually designed digital teaching materials are a relevant strategy to address the needs of science learning in prospective teacher education (Taasoobshirazi & Carr, 2008; Kustantia et al., 2023; Halim et al., 2021).

CONCLUSION

Based on the research results, the Science e-module based on *Contextual Teaching and Learning* (CTL) developed for students of the PGMI Study Program of IAI Al-Khairat Pamekasan was declared valid, practical, and effective. The validity of the e-module was demonstrated by the results of assessments by material experts, media experts, and language experts who placed the product in the category of being suitable for use in learning. The practicality of the e-module was evident from the positive responses of students, which indicated that the e-module was easy to use, interesting, and helped the independent learning process. Meanwhile, the effectiveness of the e-module was demonstrated by an increase in students' conceptual understanding after using the e-module in Science Study learning.

These findings indicate that the development of a CTL-based science e-module can be a relevant learning solution to help students understand science concepts more deeply, coherently, and contextually. In addition to supporting independent learning, this e-module also helps students connect science material to everyday life phenomena, so that learning does not stop at mere memorization. Thus, the CTL-based science e-module is suitable for use as teaching material in Science Studies courses and has the potential to support improving the quality of science learning for prospective elementary school teachers.

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