

**THE EFFECT OF A CONTEXT-BASED E-MODULE USING FLIP PDF PROFESSIONAL ON
STUDENTS' LEARNING OUTCOMES IN AN ANIMAL STRUCTURE COURSE:
THE SKELETAL SYSTEM SUBTOPIC**

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ABSTRACT

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Keywords:

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This study aimed to investigate the effect of a context-based e-module developed using Flip PDF Professional on students' learning outcomes in the Animal Structure course, particularly the Skeletal System subtopic. The study employed a quasi-experimental method using a Non-equivalent Control Group Design. The study was conducted in the Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan and involved 80 students selected through purposive sampling and assigned to an experimental group and a control group. The experimental group received instruction using a context-based e-module developed with Flip PDF Professional, whereas the control group was taught using conventional learning materials consisting of PowerPoint presentations and printed textbooks. The research instrument was a 36-item multiple-choice achievement test that had been validated for content validity, reliability, item difficulty, and discrimination index. The collected data were analyzed using an independent-samples *t*-test and normalized gain (*N*-Gain) analysis. The results showed the control and experimental groups had mean pre-test scores of 60.24 and 60.99, respectively. After the intervention, the mean post-test scores increased to 76.43 in the control group and 88.60 in the experimental group. The control group achieved an *N*-Gain score of 0.40 (moderate category), while the experimental group obtained an *N*-Gain score of 0.70 (high category). Furthermore, the independent-samples *t*-test yielded a significance value of 0.001 ($p < 0.05$), indicating a statistically significant difference in learning outcomes between the two groups. These findings demonstrate that the context-based e-module developed using Flip PDF Professional significantly improved students' learning outcomes in the Skeletal System subtopic.

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INTRODUCTION

The rapid development of digital transformation in higher education has shifted the learning paradigm from teacher-centered instruction toward student-centered learning, in which students actively construct their own knowledge. This transformation encourages lecturers to develop technology-based learning environments that can improve the quality of instruction, provide greater flexibility in accessing learning materials, and foster students' critical thinking and problem-solving skills. Furthermore, the integration of digital technology into teaching and learning is aligned with the competencies required in the 21st century, including digital literacy, communication, collaboration, creativity, and lifelong learning (Mayer, 2021; OECD, 2023).

One of the rapidly developing innovations in digital learning is the use of electronic modules (e-modules). An e-module is a systematically designed digital learning resource that enables students to learn independently through the integration of multimedia components, such as images, videos, animations, audio, hyperlinks, and interactive exercises. The integration of these multimedia elements can enhance students' attention, facilitate the visualization of abstract concepts, and reduce irrelevant cognitive load, thereby making the learning process more effective (Mayer, 2021). Previous studies have also demonstrated that e-modules can enhance students' learning motivation, learning outcomes, critical thinking skills, and self-directed learning abilities.

In recent years, Flip PDF Professional has become one of the software applications widely used for developing e-modules because of its ability to integrate various multimedia features into an attractive and interactive flipbook format that can be easily accessed through computers and mobile devices. Unlike

conventional PDF documents, Flip PDF Professional allows developers to incorporate videos, animations, audio files, interactive quizzes, hyperlinks, and simple simulations, thereby providing a more engaging learning experience. Several studies have reported that e-modules developed using Flip PDF Professional are valid, practical, and effective in improving students' learning outcomes across various biology topics (Dewi et al., 2022; Rifkanita et al., 2023).

However, the effectiveness of an e-module does not depend solely on the technology used but also on the learning approach underlying its design. One learning approach that has been widely recognized for promoting meaningful learning is Contextual Teaching and Learning (CTL). The CTL approach emphasizes the connection between academic concepts and real-life situations, enabling students not merely to memorize information but also to construct knowledge based on their own experiences. From a constructivist perspective, learning becomes more meaningful when students actively connect new concepts with their prior knowledge and experiences, resulting in deeper conceptual understanding (Johnson, 2014). Previous studies on CTL-based e-modules have also demonstrated that integrating authentic real-life contexts into learning materials can enhance students' conceptual understanding and engagement throughout the learning process (Purba et al., 2023).

The contextual learning approach is highly relevant to the Animal Structure course, particularly the Skeletal System subtopic. This topic involves considerable conceptual complexity, encompassing the organization of bone tissue, the process of ossification, bone classification, the relationship between anatomical structure and function, and skeletal adaptations across different vertebrate groups. Understanding these

concepts requires students to develop three-dimensional visualization skills, recognize relationships among biological concepts, and connect anatomical structures with their physiological functions. However, classroom instruction is still largely dominated by lecture-based learning and the use of static presentation media, leading students to focus primarily on memorizing anatomical terminology rather than developing a comprehensive understanding of the functional relationships among skeletal structures.

Initial observations in the Animal Structure course indicated that many students experienced difficulties in understanding the skeletal system because the material is highly abstract and requires effective visualization. In addition, the learning resources currently used are primarily limited to textbooks and PowerPoint presentations, providing relatively few opportunities for independent learning. Consequently, students often struggle to relate anatomical concepts to biological phenomena encountered in everyday life. Therefore, there is a need for digital learning materials that are not only visually engaging but also capable of connecting biological concepts with authentic real-world contexts, thereby fostering a more meaningful learning experience.

Previous research on Flip PDF Professional-based e-modules has predominantly focused on secondary education, with an emphasis on product development, media validity, and practical implementation. These studies have been conducted across various biology topics, including viruses, fungi, ecosystems, excretory systems, and Plantae. However, research examining the application of context-based e-modules in higher education, particularly in the Animal Structure course, remains limited. Furthermore, most previous studies have not

comprehensively evaluated the effectiveness of contextual-based e-modules in improving students' learning outcomes through an experimental research design.

Based on these research gaps, this study aims to investigate the effect of a context-based e-module developed using Flip PDF Professional on students' learning outcomes in the Skeletal System subtopic of the Animal Structure course. The findings are expected to contribute to the development of technology-enhanced biology education and provide an innovative alternative for lecturers in designing digital learning materials to improve the quality of learning in higher education.

RESEARCH METHODOLOGY

This research was conducted at the Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, Indonesia. This study employed a quasi-experimental research design using a Nonequivalent Control Group Design. Two groups participated in this study: an experimental group and a control group. The control group received conventional learning utilizing PowerPoint presentations and textbooks routinely used by the lecturer, whereas the experimental group was taught using a context-based e-module developed with Flip PDF Professional.

The research population comprised 200 undergraduate students enrolled in the Animal Structure course, distributed across five parallel classes. The research sample consisted of 80 students from two classes selected through a purposive sampling technique. The selected classes had comparable initial abilities, determined based on a pre-intervention learning achievement test.

Student learning outcomes were measured using a 36-item multiple-choice test. Prior to implementation, the instrument was analyzed for validity, reliability, item difficulty,

and discrimination index to ensure its quality and suitability for data collection.

Learning outcome data obtained from the pre-test and post-test were analyzed using an independent-samples t-test to determine differences in learning outcomes between the experimental and control groups. Additionally, the effectiveness of the intervention was evaluated using normalized gain (N-Gain) analysis.

RESULTS AND DISCUSSION

The pre-test and post-test results of the control and experimental groups were presented in Table 1.

Table 1. Pre-Test and Post-Test Analysis of Control and Experimental Groups

Groups	Test	Mean Score	N-Gain	Sig. (t-test)	
				Pre-test	Post-test
Control	Pre-test	60.24	0.40	0.289	0.001

As shown in Table 1, the initial ability of students in the control and experimental groups was relatively comparable. The mean pre-test score of the control group was 60.24, whereas the experimental group scored 60.99, representing a difference of only 0.75 points. This finding indicates that both groups possessed equivalent baseline knowledge prior to the intervention. Establishing comparable initial abilities is crucial to ensuring that any observed differences in post-test outcomes can be attributed primarily to the instructional treatment rather than initial variations in student competence. Following the learning intervention, both groups demonstrated an improvement in learning outcomes. The control group achieved a mean post-test score of 76.43, reflecting an increase of 16.19 points from the pre-test. In contrast,

the experimental group—which received instruction using the context-based e-module developed with Flip PDF Professional—achieved a mean post-test score of 88.60, representing an increase of 27.61 points. The margin of improvement of more than 11 points between the two groups indicates that the context-based e-module had a substantially greater positive impact on students' conceptual understanding compared to the conventional teaching method. The superior performance of the experimental group was further corroborated by the normalized gain (N-Gain) analysis. The control group achieved an N-Gain score of 0.40, falling into the "moderate" category, whereas the experimental group attained an N-Gain score of 0.70, which is classified as "high." This finding demonstrates that the context-based e-module was more effective in facilitating student learning than conventional instruction. In other words, students not only achieved higher test scores but also exhibited greater conceptual growth in studying the skeletal system. Furthermore, the results of the independent-samples t-test yielded a significance value of 0.001 ($p < 0.05$), indicating a statistically significant difference in learning outcomes between the experimental and control groups following the intervention. Consequently, the research hypothesis stating that the context-based e-module developed using Flip PDF Professional significantly affects student learning outcomes is supported by the empirical findings.

The research findings indicate that the implementation of a context-based e-module developed with Flip PDF Professional exerts a positive effect on student learning outcomes in the Animal Structure course, specifically on the Skeletal System subtopic. This conclusion is supported by the higher post-test scores and N-Gain achieved by the experimental group compared to the control group. These findings

suggest that interactive digital learning materials integrating authentic, real-world contexts are more effective in enhancing students' conceptual understanding than conventional instruction that primarily relies on textbooks and PowerPoint presentations (Harefa et al., 2024; Nurfadila et al., 2024).

The comparable pre-test scores between the two groups further strengthen the internal validity of this study, demonstrating that the improvement in learning outcomes can reasonably be attributed to the instructional intervention rather than baseline differences in student knowledge. According to Creswell and Creswell (2018), equivalent initial ability is a critical prerequisite in quasi-experimental research to ensure that the observed effects accurately reflect the impact of the treatment.

The substantially great improvement observed in the experimental group indicates that the context-based e-module effectively fosters deeper conceptual understanding. Unlike conventional presentation media, which typically deliver information linearly, the e-module enables students to learn at their own pace, revisit challenging concepts, and access learning materials anytime via digital devices. These characteristics support the implementation of student-centered learning, which is strongly recommended for higher education in the 21st century (OECD, 2023).

Another key advantage of the e-module lies in its integration of multimedia components, including anatomical illustrations, three-dimensional images, instructional videos, interactive exercises, and hyperlinks to supplementary learning resources. According to the Cognitive Theory of Multimedia Learning, learning becomes more effective when information is presented through a combination of text, images, audio, and animation rather than through text alone. This multimedia integration reduces extraneous cognitive load, enhances student

engagement, and facilitates the formation of mental representations for abstract concepts (Mayer, 2021). In the context of the skeletal system, multimedia visualization allows students to better comprehend the ossification process, bone tissue organization, and the relationship between anatomical structures and their physiological functions, compared to conventional static illustrations in textbooks.

The N-Gain score of 0.70 achieved by the experimental group reflects a high level of learning gain, whereas the control group only attained a score of 0.40, which falls into the moderate category. This result indicates that the context-based e-module not only improves students' final academic achievement but also enhances the overall effectiveness of the learning process. According to Hake (1998), a high N-Gain score demonstrates that students have mastered a substantial portion of the concepts they previously found difficult. Therefore, the context-based e-module is proven to be more effective than conventional instruction in fostering conceptual mastery among students.

The effectiveness of the context-based e-module can also be attributed to the application of the Contextual Teaching and Learning (CTL) approach. CTL emphasizes connecting academic concepts with authentic real-world situations, enabling students to recognize the relevance of classroom instruction to their daily experiences (Johnson, 2014). In studying the skeletal system, students are encouraged not only to grasp theoretical concepts—such as bone classification and ossification—but also to connect these concepts to practical issues, including osteoporosis, bone fractures, body ergonomics, athletic activities, and skeletal adaptations across various vertebrate species. Such contextualization fosters meaningful

learning and reinforces long-term knowledge retention.

These findings are also consistent with the principles of constructivist learning theory, which proposes that knowledge is actively constructed through meaningful learning experiences. Activities embedded in the e-module—including anatomical image analysis, instructional videos, contextual problem-solving tasks, self-assessment exercises, reflective activities, and interactive evaluations—encouraged students to construct their own understanding actively. Consequently, students developed a deeper conceptual understanding than would typically be achieved through lecture-based instruction alone (Johnson, 2014; Mayer, 2021).

In addition to improving conceptual understanding, the use of Flip PDF Professional appears to have enhanced students' learning motivation. The attractive flipbook interface, user-friendly navigation, and rich multimedia integration created a more engaging learning experience, thereby increasing students' engagement throughout the instructional process. Bond et al. (2020) argued that student engagement is one of the strongest predictors of success in digital learning environments because it encourages learners to explore instructional materials actively, participate in discussions, and reflect on their learning experiences.

The statistically significant result of the independent-samples *t*-test ($p < 0.05$) further confirms that the contextual-based e-module developed using Flip PDF Professional significantly improved students' learning outcomes. These findings are consistent with previous studies reporting that Flip PDF Professional-based learning media effectively improve students' learning outcomes, learning motivation, and independent learning skills across various biology topics (Aprilia et al.,

2022; Harefa et al., 2024; Mahmudah & Rahayu, 2024; Nurfadila et al., 2024).

The findings of this study have important implications for biology education in higher education. Lecturers are encouraged to develop digital instructional materials that integrate multimedia resources, contextual learning activities, and interactive assessments. The implementation of contextual-based e-modules supports Outcome-Based Education (OBE) while simultaneously promoting twenty-first-century competencies, including critical thinking, digital literacy, communication, collaboration, and problem-solving skills (OECD, 2023). Therefore, contextual-based e-modules developed using Flip PDF Professional represent a promising instructional innovation for biology courses that involve complex and abstract concepts requiring extensive visualization.

CONCLUSION

The findings indicate that the contextual-based e-module developed using Flip PDF Professional was effective in improving students' learning outcomes in the Skeletal System subtopic of the Animal Structure course. The experimental group showed a greater improvement in learning outcomes, with the mean score increasing from 60.99 to 88.60 and an N-Gain of 0.70 (high category), compared with an increase from 60.24 to 76.43 and an N-Gain of 0.40 (moderate category) in the control group. The independent-samples *t*-test also demonstrated a statistically significant difference between the two groups ($p = 0.001 < 0.05$). Therefore, the contextual-based e-module can be considered an effective learning resource for supporting students' understanding of the Skeletal System and improving learning outcomes in the Animal Structure course.

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