JPPIPA 12(5) (2026)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Implementation of Research-Based Modules in the Concept of Structure and Function Animal Tissue on Student's Learning Outcomes

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Received: September 29, 2025
Revised: March 17, 2026
Accepted: May 25, 2026
Published: May 31, 2026

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DOI: 10.29303/jppipa.v12i5.12984

Abstract: The concept of the structure and function of animal tissues is considered an abstract concept in biology because students cannot directly observe concrete examples to enhance their understanding. Therefore, an innovation in the form of a research-based module specifically designed to help students understand the material is needed. This study aimed to analyze the effect of implementing a research-based module on the concept of the structure and function of animal tissues on students' learning outcomes. This research employed a quasi-experimental method and Nonequivalent Control Group Design, involving two classes that a control class (conventional learning) and an experimental class (research-based module). Data collection was conducted through pre-tests and post-tests to measure students' learning outcomes. The research data were analyzed using the Independent Sample t-Test at a significance level of 5%, while improvements in learning outcomes in both classes were analyzed using the N-Gain test. The results showed that the implementation of the research-based module significantly improved students' learning outcomes ($P < 0.05$) compared to conventional learning. The average post-test score in the experimental class was 71.08, while in the control class it was 56.08, with a t-test value of 2.97 and a homogeneity value of 0.80. The N-Gain test in the control class was 0.30 (moderate category), whereas in the experimental class it was 0.52 (moderate category). Statistical analysis of the N-Gain values of both classes indicated no significant difference ($P > 0.05$). In conclusion, the implementation of a research-based module is highly suitable for teaching abstract concepts, as indicated by the improvement in students' learning outcomes.

Keywords: Concept of Structure and Function Animal Tissue; Learning outcomes; Research based module

Introduction

Everyone continues to change into a more perfect being through the process of learning, are permanent, shown through stimulus (input) and response (output). Permendiknas no. 41 of 2007 demands quality and inspiring learning, in order to form the character of students who have a scientific soul.

In every high school, biology is a core subject whose understanding is expanding. Arohman et al. (2016) explained that students studying biology must possess advanced abilities, be able to think creatively, and be able to use scientific approaches to solve problems. In addition, they are excellent at presenting scientific information, and applying Biology concepts in real life. The concept of structure and function animal tissue is mandatory concept to be learned in Biology.

This study is a continuation of research-based module development research. Considering the study's findings, information was collected that the concept of structure and function animal tissue is complicated for high school students in Pidie district to understand (Dewi et al., 2023). This is because the concept is abstract (Gustiani et al., 2021) where students cannot see directly (cannot be felt physically), because the object is very small (microscopic), it can only be seen from the picture.

How to Cite:
Dewi, E., Agustina, R., & Ridwandi. (2026). Implementation of Research-Based Modules in the Concept of Structure and Function Animal Tissue on Student's Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *12*(5), 492–497. https://doi.org/10.29303/jppipa.v12i5.12984

The low proportion of values reach the KKM indicates this (50%) (Nurmilawati, 2019). Even the KKM has not been reached by all learning outcomes (Triani et al., 2018).

According to the findings of interviews with students who have examined that concept, 85% of students anticipate learning resources that are autonomous study guides and do not rely on textbooks (Dewi et al., 2022). Additionally, Hayati (2015) clarified that there is little interest in reading biology text-books, and, 76.7% of learners had trouble remembering the lessons they had learned (Fadilah et al., 2019). This resulted in the failure to achieve every learning indicator that had been prepared. Thus, an innovation in during the educational process is highly expected to stimulate an increase in understanding of the concept of structure and function animal tissue.

One innovation that can be used to address this problem is the development and implementation of research-based learning modules. This module combines research findings with theory to help students grasp how the concepts they acquired are implemented in real-world situations. This module was created especially for independent learning facilities. This self-directed learning is needed to develop learning independence (Doyan et al., 2020; Permana, 2024). The research-based module used in this study is the result of the researcher's research development based on student needs analysis (Dewi et al., 2022). This module has been proven valid without revision (81.17%) and practical to use (90.80%) (Dewi et al., 2023).

The novelty of this study lies in the implementation of a research-based module that had been previously developed and validated, and subsequently tested directly for its effectiveness in Biology learning on the concept of the structure and function of animal tissues. In addition, the research-based module used in this study does not merely present theoretical content, but also integrates actual research findings and relevant scientific contexts, thereby providing students with a more meaningful learning experience compared to conventional modules that generally contain only summarized material. Thus, this study offers an innovative approach in the form of a contextual research-based teaching material, particularly for abstract and microscopic topics such as the structure and function of animal tissues.

Various previous studies have showed that the use of modules may increase students' independence in learning (Handayani et al., 2018), learning becomes efficient and effective (Nurmilawati, 2019) and improve learning outcomes (Hidayat et al., 2017). This study is important because it provides a tangible contribution to the development of innovative teaching materials that are appropriate for the abstract and microscopic characteristics of biology content, meet students' needs for independent learning, and provide empirical evidence that research-based modules as an instructional innovation truly have an impact on learning outcomes. In addition, the findings of this study can serve as a scientific basis for teachers and schools to implement research-based modules as a more effective alternative teaching material, while also supporting the implementation of student-centered learning and improving the quality of Biology instruction.

Method

The research was conducted at SMAN 1 Simpang Tiga, Simpang Tiga District, Pidie Regency from February to November 2024. This research is classified as a quasi-experiment with Nonequivalent Control Group Design (Table 1).

Table 1. Nonequivalent Control Group Design

Class			Information
Experimental Class	O_1	X_E	O_2
Control Class	O_3	X_K	O_4

Information
O1 : Experimental class pre-test
O2 : Experimental class post-test
O3 : Control class Pre-test
O4 : Control class Post-Test
XE : Experimental class treatment
XK : Control class treatment (Sugiyono, 2019)

Nonequivalent Control Group Design is a study where there are 2 (two) selected groups, where the first group is given treatment (experimental class) and the other is not given treatment (control class) (Purwanto et al., 2017). In the experimental class, research-based modules are utilized to teach the concept of structure and function animal tissue, whereas in the control class, conventional educational methods—such as lectures supported by textbooks—are employed. Learning in the control and experimental class are carried out at the same time and length of learning hours. This is useful for minimizing interaction between classes (Nahartyo, 2013).

Population and Sample

Purposive sampling was chosen in determining the class used. And, to identify the control and experimental classes, random sampling was used. Learning the concept of animal tissue structure through the implementation of a conventional approach (control class) and the implementation of research-based modules (experimental class). The number of students in both classes is the same, namely 25 students.

Data Collection

Test technique is used for data collection. Test is given 2 (two) times, before learning takes place (pre-test), and after learning takes place (post-test) in both treatment classes. The questions (instruments) tested are 30 (thirty) multiple-choice questions with 5 alternative answer choices.

Data Analysis Techniques

The pre-test and post-test learning results of the students as a result of the use of research-based modules on the concept of animal tissue structure and function served as the riset parameters. Sample Independent T-Test and N-Gain were used to examine the data (Table 2).

Table 2. N-Gain Criteria

N-Gain	Criteria
< 0.30	Low
≤ 0.30 N-Gain < 0.70	Currently
≥ 0.70	High

The purpose of the independent sample t-test is to compare the mean learning outcomes of students in the two treatment groups to determine whether there is a statistically significant difference between them (Field, 2013; Pallant, 2020). Meanwhile, N-Gain is used to analyze learning effectiveness by measuring the improvement in learning outcomes from the pre-test to the post-test in both treatment classes, taking into account the difference between initial and final scores to determine the magnitude of learning gains (Sinharay, 2022). This approach is commonly used in educational research to evaluate the effectiveness of instructional interventions (Outhwaite et al., 2020).

Result and Discussion

Examination in the pre- and post-tests to collect the data. A pre-test is carried out to measure the initial ability of students towards the concept studied before the implementation of learning, and the ultimate ability is measured with a post-test (learning outcomes) of students studying the implementation of Conventional education in the control group and the implementation of research-based modules in the experimental group. Table 3 and Table 4 present the the data analysis of the pre-test and post-test scores, respectively.

Table 3. Pre-test Data Analysis

Treatment Group	Pre-test	Homogeneity	T-Test
Control Class	42.80	0.64	1.59
Experimental Class	36.96		

Table 3 shows that students from both treatment classes have the same initial abilities (P>0.05), as evidenced by the pre-test scores tending to be the same between the two classes, namely 42.80 in control class and 36.96 in experimental class, and the homogeneity value is 0.64. Initial ability is a basic ability that already exists in students before starting new learning, knowledge, experience or skills (Sya'roni et al., 2018). This ability is measured as a foundation for new learning (Azizah et al., 2021). Handini (2012) argue that measuring initial abilities is very useful for teachers in identifying students' learning styles to determining the learning model used in subsequent learning.

Table 4. Post-Test Data Analysis

Treatment Group	Post Test	Homogeneity	T-Test
Control Class	56.08	0.80	2.97
Experimental Class	71.08		

Table 4 showed the post-test score at control class is 56.08, lower than experimental class, which is 71.08, and the homogeneity score is 0.80 (homogeneous). The post-test result is the level of achievement of the objective indicator after learning process is completed on the concept of structure and function animal tissue (Siregar et al., 2023). The low post-test score at control class compared with the experimental class is caused the conventional approach used to be ineffective in increased learning outcomes for the concept of structure and function animal tissue. Conventional education includes teacher-centered guidance, communication in one direction (from the teacher alone), and learning strategies that primarily concentrate on concept mastery (Magdalena, 2018). This condition causes student passivity (Adila et al., 2020), students get bored quickly (Hasanah et al., 2022) and weak critical thinking skills (Rahayu et al., 2024).

In addition to the implementation of the conventional approach, the low scores in the control class were also caused by the learning concept itself. The results of previous studies obtained information that 59.98% of students stated that the concept of structure and function animal tissue was a difficult concept to learn (Dewi et al., 2022). This concept is abstract, students cannot see each object being studied in real terms because it is microscopic (Nurmilawati, 2019). Fuadi et al. (2020) also explained that the choice of textbooks, non-contextual learning, misconceptions, and reading skills are also the main keys to low student abilities.

The implementation of research-based modules on students from the experimental class was able to improve learning outcomes, compared to the control class (Table 2). This increase was due to the use of research-based modules providing active and

interactive learning experiences for students so that the concepts learned could be easily understood. Here, students not only gain knowledge, but also develop critical thinking skills (Muliyadi et al., 2026; Oktaviana et al., 2022) and, motivate students to learn (Januarti et al., 2024; Munandar et al., 2024; Pinasthika et al., 2022).

Triani et al. (2018) explained that research-based modules are teaching materials developed based on research results. Where the material is presented in a more contextual manner, more in-depth because it presents scientifically proven facts, and more interesting. Research-based modules are specifically designed for independent learning facilities. This independent learning is needed to develop learning independence (Fitriati, 2018).

Research-based modules are presented systematically so that users can not only learn, but are able to increase their capacity in using scientific knowledge, identifying questions, concluding based on facts, and making decisions on changes that occur whether or not there are educators. The research-based module used in this study is the outcome of development made by researchers in earlier investigations. The results of module validity test showed the module was valid without revision (81.17%) and practical to use (90.80%) (Dewi et al., 2023).

Table 5 displays the result of the data analysis on the two treatment classes' increase in learning outcomes between the pre-test and post-test (N-Gain). Learning outcomes at the two treatment groups (control and experimental classes) have increased, as evidenced by the N-Gain data analysis results. It is known the N-Gain value of control class is 0.30 and experimental class is 0.52. Although the N-Gain value in both classes is moderate category, statistically it is stated that there is a difference between the two classes ($P < 0.05$). The N-Gain value is 0.52 in the experimental class shows that the implementation of the research-based module that has been developed by researchers is effective for use in the learning, providing convenience and smooth learning activities and interactions between teachers and students.

Table 5. N-Gain Acquisition

Treatment Group	N-Gain	Category	Homogeneity	T-Test
Control Class	0.30	Currently	0.21	3.65
Experimental Class	0.52	Currently		

The increase in students' learning outcomes in control class proves that conventional learning also provides teachers with the opportunity to impart all knowledge and learning experiences to students in a comprehensive and structured manner (Gunawan et al., 2020). Conventional learning can encourage students to be more focused (Wulandari, 2022).

Conclusion

The research-based module implemented in this study was designed in accordance with students' independent learning needs and was able to help students understand the abstract concept of the structure and function of animal tissues. At SMAN 1 Simpang Tiga, the implementation of the research-based module on the concept of the structure and function of animal tissues was able to improve students' learning outcomes, as indicated by the mean post-test score of the experimental class, which was 71.08, higher than that of the control class at 56.08, with a t-test value of 2.97 and a homogeneity value of 0.80 ($P < 0.05$). In addition, the N-Gain score in the experimental class reached 0.52, categorized as moderate, while the control class obtained a score of 0.30. The findings of this study provide practical contributions to the development of biology teaching materials, particularly for abstract topics that are difficult for students to understand.

Acknowledgments
We would like to express our gratitude to SMAN 1 Simpang Tiga, Simpang Tiga District, Pidie Regency, who have facilitated the completion of this research.

Author Contributions
Conceptualization, E. D.; development of the theoretical framework, E. D.; methodology, R. A.; data collection, R. A. and R.; formal analysis, R. A.; visualization, R.; writing—original draft preparation, E. D.; writing—results and discussion preparation, R.; writing—review and editing, E. D., R. A., and R. All authors have read and agreed to the published version of the manuscript.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

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