


Conceptual Understanding of the Human Circulatory System Among Preservice Elementary Teachers

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Abstract: This study aimed to analyze the level of conceptual understanding of the circulatory system among second-semester students of Class C in the Primary School Teacher Education Program at Nias University. A descriptive quantitative approach with a survey design was employed. The sample consisted of 37 students selected through total sampling. Data were collected using a self-assessment questionnaire consisting of 20 statements regarding circulatory system concepts and analyzed descriptively using mean scores and percentages. The results showed that students demonstrated a high level of conceptual understanding, with an average score of 3.82 and a percentage of 76.35%. The highest mean score (4.27) was obtained for the concept related to the function of the circulatory system in distributing substances needed by the body, while the lowest mean score (3.51) was found for the concept concerning the relationship between the lymphatic system and the circulatory system. Overall, all statement items were categorized as high to very high. These findings indicate that students possess a good understanding of circulatory system concepts, although understanding of the lymphatic system still requires improvement. The results can serve as evaluation material for improving science learning in teacher education programs.

Keywords: conceptual understanding, circulatory system, PGSD students, science learning, prospective elementary school teachers

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Introduction

The circulatory system is an important topic in Natural Science (IPA) learning, studied from elementary school to college. This material covers basic concepts, including heart function, blood components, the mechanisms of large- and small-circulation blood flow, blood vessels, and disorders that can occur in the circulatory system. A good understanding of the circulatory system is essential for prospective elementary school teachers because it is part of the science curriculum taught in elementary schools. A good mastery of the concept will help teachers explain the material accurately and facilitate students' understanding of abstract scientific concepts. This is in line with Sofia et al. (2023), who stated that science learning in elementary schools includes the circulatory system, and that students need to understand this concept well, so that teaching materials and learning media are needed to support the learning process. Therefore, mastering the concept of the circulatory system in college is an important preparation for PGSD students to become competent educators.

Students in the Elementary School Teacher Education (PGSD) study program are required to have a solid understanding of scientific concepts to equip them to teach at the elementary level. One of the science concepts they must master is the human circulatory system. However, various studies have shown that prospective teacher students still experience difficulties in grasping abstract and complex science concepts, both conceptually and in their application (Adelina, 2026). These difficulties can impact the quality of students' understanding of the material they will later teach.

Conceptual mastery is a key competency that elementary education students must possess as future elementary school teachers. Strong conceptual mastery not only helps students understand the material in depth but also supports their ability to explain concepts to students accurately. Hasnawati et al. (2023) state that mastery of science concepts is a competency required of elementary education students to prepare them to become professional teachers. Therefore, the level of students' conceptual mastery requires attention to ensure that the learning process in elementary schools can be implemented effectively.

Inadequate conceptual understanding among prospective teachers can impact the learning process in elementary schools. Teachers who do not fully grasp a concept may inadvertently convey inaccurate information to students, potentially leading to misconceptions. This situation warrants attention because teachers play a crucial role in fostering students' scientific understanding from an early age. Surya et al. (2023) state that misconceptions among

prospective teachers, if left unaddressed, can lead to persistent misconceptions among students and adversely affect learning quality outcomes.

Previous research indicates that pre-service teachers' conceptual understanding of the circulatory system still requires attention. Syahriani (2016) found that biology education students still hold misconceptions regarding the circulatory system, particularly concerning the processes of blood circulation and blood vessels. These findings indicate that prospective teachers remain susceptible to misunderstandings regarding the basic concepts of the circulatory system. However, most previous studies have focused on identifying misconceptions and were generally conducted among biology education students. Meanwhile, research specifically examining the level of students' conceptual understanding of the circulatory system in the Elementary School Teacher Education (PGSD) program remains relatively limited. In fact, PGSD students have different characteristics and academic needs compared to biology education students, as they are being prepared to teach a variety of fundamental science concepts to elementary school students. Based on the literature review conducted, no study has been found that specifically examines the level of conceptual understanding of the circulatory system among second-semester PGSD students in Class C at the University of Nias who are currently taking the course Advanced Basic Science Concepts for Elementary School.

Given these circumstances, research is needed to provide an overview of the level of understanding of the circulatory system among Elementary School Teacher Education (PGSD) students. Information on this level of conceptual understanding is important as an evaluative tool to identify concepts that students still find difficult to grasp, thereby serving as a basis for improving the learning process in the relevant course.

Based on the above description, this study aims to analyze the level of understanding of the circulatory system concept among second-semester Elementary School Teacher Education (PGSD) students in Class C at the University of Nias. This study is expected to provide an overview of students' level of understanding of the circulatory system concept and serve as evaluation material for the development of science education in the PGSD Study Program.

Method

This study employs a descriptive quantitative approach with a survey design to investigate the level of conceptual understanding of the circulatory system among second-semester Elementary School Teacher Education (PGSD) students in Class C at Nias University. The descriptive quantitative method was selected as it enables a systematic description of students' understanding based on quantitative data. According to Arikunto (2019), descriptive research aims not to test specific hypotheses, but to portray variables, phenomena, or conditions as they exist. Data were collected directly through a structured questionnaire administered simultaneously to all participants. The survey design was chosen for its efficiency and ability to provide structured data from all respondents.

The population in this study consisted of all second-semester students in Class C of the Elementary School Teacher Education Program (PGSD) at Nias University who were enrolled in the course "Fundamentals of Elementary School Science" during the 2025/2026 academic year, excluding members of the research group. The sampling technique used was total sampling, in which the entire population was selected as the research sample (Sugiyono, 2019). The final sample consisted of 37 students, representing all second-semester PGSD Class C students at Nias University, excluding members of the research group. Total sampling was chosen because of the relatively small population size, allowing all eligible individuals to be included as respondents and thereby yielding more comprehensive and representative data.

The research instrument used was a self-assessment questionnaire designed to measure the level of conceptual understanding of the circulatory system. The questionnaire consisted of 20 items developed based on curriculum indicators for the circulatory system, including the structure and function of the heart, blood vessels, blood components, mechanisms of blood circulation, the lymphatic system, and disorders of the circulatory system. Responses were rated using a five-point Likert scale with the following categories:

Table 1. Likert Scale Categories

Score	Category
1	Don't understand at all
2	Don't understand
3	Understand somewhat
4	Understand
5	Understand very well

A higher score assigned by respondents indicated a higher level of understanding of the circulatory system. Data collection was carried out in June 2026 by distributing an online questionnaire to all participants via Google Forms. Google Forms was selected as it enables efficient data collection, is easily accessible to respondents, and allows for the automatic tabulation of responses, thereby streamlining data processing (Sianipar, 2019). The collected data were subsequently exported to Microsoft Excel for descriptive processing and analysis.

Data analysis was conducted using descriptive statistics, including calculation of the mean, percentages, and categorization of understanding levels (Yusuf, 2017). The mean was used to determine both item-specific and overall levels of student understanding. Percentages were calculated to illustrate the extent to which respondents' scores approached the maximum possible score.

To calculate the mean, the following formula was used:

$$\text{Mean} = \frac{\text{total score}}{\text{number of respondents}}$$

The formula used to calculate the percentage score is as follows:

$$\text{percentage} = \frac{\text{score obtained}}{\text{maximum possible score}} \times 100\%$$

The categories for levels of understanding were determined based on class intervals, calculated using the following formula (Sudijono, 2018):

$$\text{Interval (I)} = \frac{\text{maximum score} - \text{minimum score}}{\text{number of categories}}$$

For a five-point scale (ranging from "Very well understood" to "Very poorly understood") with a maximum score of 5 and a minimum score of 1, the calculation is as follows:

$$I = \frac{5 - 1}{5} = 0.80$$

Table 2. These categories of understanding levels were used to interpret the average scores obtained by respondents according to the established class intervals.

Interval mean	Category
4,21–5,00	Very high
3,41–4,20	High
2,61–3,40	Moderate
1,81–2,60	Low
1,00–1,80	Very low

Results

Table 1. Overall Level of Conceptual Understanding of the Circulatory System

Number of Respondents	Maximum Score	Total Score	Mean	Percentage	Category
37	3.700	2.825	3,82	76,35%	Tinggi

Based on the analysis of data from 37 respondents across 20 statement items, a total score of 2,825 was obtained out of a maximum possible score of 3,700. The results yielded a mean score of 3.82, corresponding to a percentage of 76.35%. According to the established category intervals, the level of conceptual understanding of the circulatory system among second-semester PGSD students in Class C at the University of Nias is classified as high.

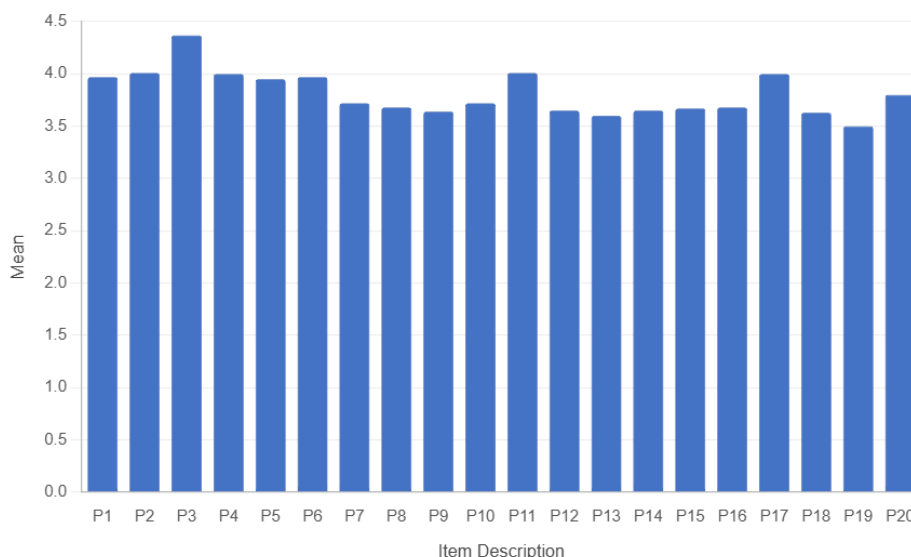


Figure 1. Mean Conceptual Understanding of the Circulatory System for Each Statement Item

As presented in Figure 1, the mean scores for each item range from 3.51 to 4.27. The item with the highest mean score is P3, at 4.27, which is categorized as “very high,” while the item with the lowest mean score is P19, at 3.51, classified as “high.” Overall, all items fall within the “high” to “very high” categories.

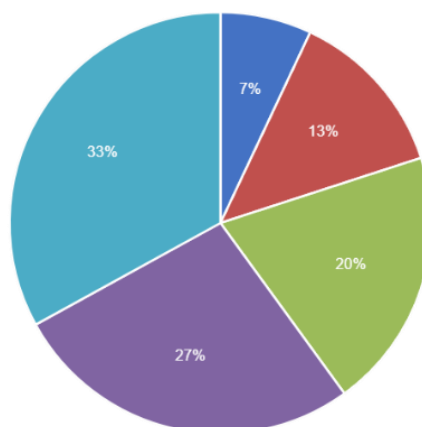


Figure 2. Distribution of Respondents' Answers

Analysis of the distribution of respondents’ answers shows that most students selected the “Understand” (score of 4) and “Strongly Understand” (score of 5) categories for the majority of statement items. In contrast, the “Strongly Do Not Understand” (score of 1) category was selected very infrequently. These findings indicate that students possess a strong understanding of the circulatory system concept as measured in this study.

Discussion

The findings of this study indicate that the level of conceptual understanding of the circulatory system among second-semester PGSD students in Class C at Nias University is classified as high, with a mean score of 3.82 and a percentage of 76.35%. These results suggest that the majority of students have grasped the basic concepts of the circulatory system presented in the “Advanced Basic Science Concepts for Elementary School” course. This high level of understanding constitutes a crucial foundation for these students as prospective elementary school teachers who will be responsible for delivering science instruction to their future pupils. According to Tortora and Derrickson (2013), the circulatory system is one of the fundamental concepts in biology that is essential to understand, as it relates to organ function and human survival (Zebua et al., 2026).

The high level of student understanding may be attributed to the instructional strategies implemented during the course. Structured and systematic learning activities have provided students with opportunities to engage more deeply with the concepts of the circulatory system. Furthermore, as the circulatory system is a topic that has been introduced at previous educational levels, students already possess prior knowledge that facilitates deeper comprehension of the

material. Prior knowledge plays a critical role in the formation of new concepts, as students tend to connect newly acquired information with their existing knowledge base (Adelina, 2026).

The results of this study indicate that students possess a good understanding of various concepts related to the circulatory system. These concepts include the functions of the circulatory system, the role of the heart, types of blood vessels, blood components, and the mechanisms of blood circulation in the human body. According to Setiadi (2020), understanding these concepts is essential, as the circulatory system is responsible for transporting oxygen, nutrients, hormones, and various other substances necessary for normal physiological functions.

Analysis of each statement item revealed variations in students' levels of understanding across the concepts measured. Certain items received higher mean scores than others, indicating that not all concepts pose the same level of difficulty for students. Concepts that are more concrete and commonly encountered in everyday life tend to be more easily understood than those that are more abstract. Nevertheless, overall, all items fell within the high category, suggesting that students demonstrated a sufficiently strong grasp of the circulatory system concepts.

The item with the highest mean score was P3, with a mean of 4.27. This item pertains to the function of the circulatory system in distributing substances required by the body. The high score on this item suggests that students possess a strong understanding of the primary role of the circulatory system as the body's transport mechanism. This concept is relatively easy to comprehend, as it is frequently addressed in science education and is directly related to daily life. Therefore, students are more likely to connect this concept with their prior experiences and knowledge.

In contrast, the item with the lowest mean score was P19, with a mean of 3.51. This item concerns the relationship between the lymphatic system and the circulatory system. Although this score still falls within the high category, it indicates that students' understanding of this concept is comparatively lower than for other concepts. This may be attributed to the fact that the lymphatic system is not explored in depth during lectures, unlike the heart, blood, and blood vessels, which are more frequently emphasized. Furthermore, the lymphatic system involves more complex concepts, as it interacts with both the circulatory and immune systems. Students are required not only to understand the function of lymphatic vessels, but also to comprehend their roles in maintaining fluid balance and supporting the body's defense mechanisms against disease.

The results indicate that students tend to find it easier to understand concrete concepts compared to those that require an understanding of the relationships between organ systems. Comprehending the relationship between the lymphatic system and the circulatory system necessitates the ability to integrate multiple concepts simultaneously. Therefore, greater emphasis should be placed on the instruction of the lymphatic system to enable students to develop a more comprehensive understanding of the circulatory system as a whole and its connections with other bodily systems. The use of visual learning media and concept-based instructional approaches may serve as effective alternatives to enhance students' understanding of this material.

The findings of this study have important implications for the preparedness of students as prospective elementary school teachers. Teachers with a strong conceptual understanding are better equipped to explain subject matter accurately and systematically to their students. Conversely, insufficient conceptual understanding may result in misconceptions that negatively impact the learning process. Thus, strengthening students' conceptual understanding of science during their undergraduate education is a crucial component in preparing professional and competent future teachers.

The results of this study are consistent with the findings of Rahmatih and Fauzi (2024), which demonstrated that prospective teachers possess a relatively strong understanding of basic science concepts; however, the teaching models employed require further enhancement to become more interactive. These findings are further supported by Fatimah (2017), who reported that pre-service elementary school teachers' conceptual understanding of science was classified as high, with 82.64% of students exhibiting such understanding. These similar results suggest that PGSD students generally possess an adequate knowledge base for studying the science material to be taught in elementary school. Nevertheless, improvements in the quality of instruction remain necessary to ensure that students' understanding becomes deeper and more consistent across all concepts studied.

Conclusion

A study conducted on 37 second-semester PGSD students in Class C at Nias University yielded an average score of 3.82, representing a pass rate of 76.35%. Referring to the predetermined categories, the students' understanding of the concept of the circulatory system falls into the high category. This finding indicates that the students already have adequate mastery of various concepts in the circulatory system, including circulatory functions, blood-forming elements, heart structure, blood vessels, and how the circulatory system works in the body.

Based on the analysis of each statement item, the concept most mastered by the students is related to the role of the circulatory system in distributing substances needed by the body. Meanwhile, the concept that is still considered less mastered is the relationship between the lymphatic system and the circulatory system. Nevertheless, all statement

items still fall into the high category. Thus, it can be concluded that second-semester PGSD Class C students at the University of Nias generally have a good understanding of the concepts of the circulatory system, although their understanding of the lymphatic system still needs to be improved so that their mastery of the concepts can be more comprehensive.

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AI Usage Statement

The authors declare that Artificial Intelligence (AI) tools were used during the preparation of this manuscript. ChatGPT was utilized to assist with language translation, grammar checking, sentence editing, and manuscript structuring. AI was used exclusively as a writing support tool and did not contribute to the generation of research data, data analysis, interpretation of findings, or scientific conclusions. All outputs generated by AI were critically evaluated, verified, and edited by the authors. The authors remain fully responsible for the originality, accuracy, integrity, and scholarly content of this manuscript.

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