Analysis of Factors Influencing Literacy and Numeracy Skills of Biology Education Students at Universitas Lancang Kuning

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ABSTRACT

This study aims to analyze the factors affecting biology education students' literacy and numeracy skills, focusing on the influence of previous education quality, learning motivation, social environmental support, and learning facilities. The study employs a descriptive approach with Confirmatory Factor Analysis. The respondents' achievement level for the Previous Education Quality variable (X1) was moderate (76.22%). The Learning Motivation variable (X2) had a Total Correct Rate (TCR) of 84.04%, which falls under the good category. The Social Environmental Support variable (X3) scored 58.63%, categorized as poor. The Learning Facilities variable (X4) obtained a TCR of 55.39%, also in the poor category. After conducting the confirmatory factor analysis, two factors were identified, explaining 60.47% of the variance from the original variables, with the remaining 39.53% explained by other unexamined variables in this study. With a better understanding of these factors, it is hoped that this research can provide strategic recommendations for higher education institutions in developing curricula, learning methods, and learning environments that can effectively improve students' numeracy and literacy skills in the field of biology.

Introduction

Numeracy and literacy skills are basic abilities that are very important for every individual, especially in the world of higher education. Numeracy skills, which involve the ability to calculate, understand data, and solve quantitative problems, as well as literacy skills, which include the ability to read, write, and understand information critically, are very necessary for students to

support an effective learning process (Ishaq et al., 2019). These skills are not only important for improving understanding of academic concepts, but also play an important role in preparing students to face challenges in the world of work (Tout, 2020).

(Simamora & Akhiruddin, 2022) said that numeracy skills are an individual's ability to understand, interpret, and use mathematical concepts in various contexts of daily life. These skills include the ability to perform basic arithmetic operations, understand numerical data, analyze graphs or tables, and solve problems with a mathematical approach. Numeracy is not just counting, but also includes understanding and applying numerical concepts in real situations, thereby enabling individuals to make informed decisions based on existing data (Napoli & Purpura, 2018). (Jayaraman et al., 2018) emphasize the importance of numeracy skills in higher education because these skills are considered essential to support students' understanding in science and technology-based disciplines. Students with good numeracy skills have critical and logical thinking abilities that help them solve complex problems and process quantitative information accurately (Yuwono et al., 2024).

Literacy skills are generally defined as an individual's ability to understand, analyze, and interpret information from various texts critically and effectively. Literacy includes not only the ability to read and write, but also critical thinking skills in understanding context and meaning which are important for communicating and actively participating in society (Nadjamuddin & Hulukati, 2022). Good literacy skills enable individuals to make the right decisions, solve problems, and understand various information from various sources, including scientific literature, popular texts, and digital media (Wardhani et al., 2022). Several studies also highlight aspects of digital and information literacy, which are increasingly important in the current technological era (Fuadi & Mulyani, 2022). Digital literacy includes the ability to use technology effectively to search for, evaluate and utilize relevant

information (Putra & Damanik, 2023). Thus, literacy skills in this modern era are often considered to include skills in reading, writing, critical thinking, and interacting with technology (Zainudin & Fatah, 2023).

Students majoring in Biology Education, in particular, are required to have good numeracy and literacy skills because biology learning often involves data processing, understanding complex scientific texts, and the application of quantitative concepts such as statistics and scientific logic in laboratory practice c However, (Lechner et al., 2021) studies show that students' numeracy and literacy skills still face significant challenges. For example, there is a gap between the theoretical knowledge obtained by students and the ability to apply it practically, especially in terms of interpreting data and understanding complex scientific literature.

Various factors are thought to influence these numeracy and literacy skills, such as the quality of education received by students at previous levels, learning motivation, as well as social environmental support and learning facilities (Piper et al., 2018). The quality of education at previous levels, such as primary and secondary education, has a significant role in shaping students' literacy and numeracy skills at the higher education level (Hasan Basri et al., 2021). Effective education and a competency-based curriculum can build a strong foundation of basic skills, such as understanding numerical concepts and critical literacy skills (Nudiati, 2020). Research shows that students who have received quality education from an early age tend to have better analytical skills and conceptual understanding (Bonifacci et al., 2021).

Learning motivation is also an important factor that influences literacy and numeracy skills. Students who have high motivation are usually more active in the learning process, look for additional learning resources, and are more open to developing critical and analytical thinking skills (Reder et al., 2020). Intrinsic motivation (encouragement to learn from within oneself) and extrinsic motivation (encouragement from the environment or certain incentives) can increase students'

interest in learning and hone numeracy and literacy skills independently (Muliantara & Suarni, 2022).

A supportive social environment, whether from family, friends or society, has a positive impact on student skills. Support from parents, for example, can increase students' self-confidence and desire to develop literacy and numeracy skills (Raraswati et al., 2021). Apart from that, a conducive environment such as a study group or academic community can help students discuss, exchange information, and improve literacy and numeracy skills through interaction and collaboration (Garcia-Retamero et al., 2019).

Learning facilities, including access to libraries, laboratories, and technology, have a major influence on students' skills. Adequate facilities enable students to access relevant information sources, carry out experiments, and learn through direct practice (Cheung et al., 2021). Apart from that, the availability of reading materials and digital learning resources also increases students' accessibility to information and helps develop literacy and numeracy skills (Fitriana & Khoiri Ridlwan, 2021).

In Indonesia, the role of higher education in improving students' numeracy and literacy skills has become a major concern, especially in order to achieve educational goals that are relevant to global needs and technological advances (Aflalo, 2014). The challenge in improving these basic skills is increasingly felt considering the limited research on factors that specifically influence numeracy and literacy skills in certain majors, such as Biology Education (Arsyad, 2023). This research aims to analyze the factors that influence students' numeracy and literacy skills in the Biology Education study program. With a better understanding of these factors, it is hoped that this research can provide strategic recommendations for higher education institutions in developing curricula, learning methods and learning environments that are able to effectively improve students' numeracy and literacy skills in the field of biology.

Method

In this research, the type of research used is descriptive research with confirmatory factor analysis. Descriptive Research is research that describes or explains factually the events that are happening without adding anything to it (Nursyafti & Purwanto, 2021). Meanwhile, confirmatory factor analysis helps see the extent to which a factor influences the research object. This research is designed to find information in a situation, where the information can test the hypothesis of the subject being studied. The data that will be described are factors that will influence the numeracy and literacy skills of Biology Education students at Universitas Lancang Kuning.

Research variables are everything determined by the researcher in the study to be understood and researched in order to obtain conclusions. Based on their function, variables are divided into several types, and in this research two main variables are used: independent variables and dependent variables. The independent variable is a variable that influences other variables, while the dependent variable is a variable that is influenced by the independent variable. The independent variables in this research are the quality of previous education, learning motivation, social environmental support and learning facilities. Meanwhile, the dependent variable is numeracy and literacy skills.

The population in this study consists of all students enrolled in the 3rd and 5th semesters of the Biology Education Program, Faculty of Education and Vocational Education, Universitas Lancang Kuning, totaling 74 students. Since the total population is relatively small and all members meet the inclusion criteria, a total sampling technique was used, meaning that all 74 students were included as the research sample.

Data collection will use questionnaires and analyzed by confirmatory factor analysis. Confirmatory factor analysis aims to obtain a relationship or connection between the four variable factors X1, X2, X3 and X4 so as to produce one or more new variables called factors that still describe

the previous variables (Firdaos, 2016). Confirmatory factor analysis in this research will be carried out using the SPSS program version 30.00. The following are the steps for carrying out the analysis.

Results and Discussion

This study produces a description of the factors that influence the literacy and numeracy skills of Biology Education students at Lancang Kuning University with 4 variables, namely Previous Education Quality (X1), Learning Motivation (X2), Social Environmental Support (X3) and Learning Facilities (X4).

The level of achievement of respondents in each variable in this study varies. In the Previous Education Quality variable (X1), the TCR value obtained was 76.22% which is included in the sufficient category. The Learning Motivation variable (X2) obtained a TCR value of 84.04% which is included in the good category. The Social Environmental Support variable (X3) obtained a value of 58.63% which is included in the less category. The Learning Facilities variable (X4) obtained a TCR value of 55.39 which is still included in the less category.

The confirmatory factor analysis began by testing the feasibility of the variables by looking at the results of the Barlet's test and the Kaisar Mayer Olkin test. Data that passes the Emperor Mayer Olkin test must have a significance value of >0.500, while for the Barlet's test value the data must have a value of <0.05. If the data tested has passed this initial test, then the data is eligible to take the next test. The results of the Barlet's test and the Kaiser Mayer Olkin test of this study can be seen in table 1 below.

Table 1. Barlet's test and the Kaiser Mayer Olkin test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.580
Bartlett's Test of Sphericity	Approx. Chi-Square	7.499
	Df	6
	Sig.	0.00

The data presented in table 1 shows the results of the Kaisar Mayer Olkin Measure of Sampling Adequacy test in this study is 0.580 and the significance value is 0.000. Because the value is above 0.500 (0.580 > 0.500) then the variable is worthy of further analysis and the significance is small from 0.050 (0.000 < 0.050) which means there is a fairly large correlation between each original variable.

The next stage of analysis that must be passed by this research data is the Anti Image Matrices Correlation test with Measures of Sampling Adequacy (MSA) which will determine the feasibility of the initial variables as factor compilers. The variable is declared feasible if the MSA value is 0.50 - 1.00. If a value of less than 0.50 is obtained, the variable will be removed from the arrangement of other variables that will enter the next analysis stage. The Anti image matrices correlation test in this study can be seen in table 2 below.

Table 2. Anti Image Matrices Correlation Test

Anti-image Matrices					
		X1	X2	X3	X4
Anti-image Covariance	X1	0.968	0.020	0.141	0.071
	X2	0.020	0.959	0.035	0.191
	X3	0.141	0.035	0.946	0.156
	X4	0.071	0.191	0.156	0.924
Anti-image Correlation	X1	0.566[a]	0.021	0.148	0.075
	X2	0.021	0.678[a]	0.037	0.203
	X3	0.148	0.037	0.530[a]	0.167
	X4	0.075	0.203	0.167	0.517[a]

In table 2, it can be seen that the data with the code "a" is the Measures of Sampling Adequacy (MSA) value of each variable. Because all variables get an MSA value greater than 0.500, all variables are worthy of further analysis.

Table 3. Communalities Test

Communalities		
	Initial	Extraction
X1	1.000	0.522
X2	1.000	0.730
X3	1.000	0.560
X4	1.000	0.606

Table 3 shows the results of the communalities analysis on each research variable. The closer to 1 the value obtained by each variable, the more capable the factor is in explaining the variance of the original variable. In table 3, it can be seen that variable X2 (learning motivation factor) obtained the highest value by explaining 0.73% of the formed factor.

The next step taken is to form a new factor from the previously existing factors (Variables X1, X2, X3 and X4). Analysis of the Total Variance Explained will be carried out in this step to form a new factor.

Table 4. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.335	33.368	33.368	1.335	33.368	33.368	1.224	30.588	30.588
2	1.084	27.102	60.470	1.084	27.102	60.470	1.195	29.882	60.470
3	.849	21.215	81.685						
4	.733	18.315	100.000						

Based on table 4, it can be seen that there are 2 factors that have eigenvalues > 1, meaning that the 2 factors are formed from a series of analyzes that have been passed. The variance of factor 1 is (1.335/4) x 100% = 33.37% of the total variance. The variance of factor 2 is (1.084/4) x 100 = 27.10% of the total variance. Thus, the total variance of the two factors is 60.47% which can be interpreted that the 2 factors formed are able to explain 60.47% of the variability of the four original variables. The remaining 39.53% is influenced by other variables that were not examined in this study.

The next step is to group the original variables into factors that have been formed from the previous analysis. The grouping data can be seen in table 5 below.

Table 5. Rotate Component Matrix

Rotated Component Matrixa

		Component	
		1	2
Previous Education Quality (X1)		0.721	0.044
Learning Motivation (X2)		0.193	0.833
Social Environmental Support (X3)		0.741	0.105
Learning Facilities (X4)		0.342	0.699

Based on Table 5, it can be seen that the previous education quality variable (X1) and the Social Environmental Support variable (X3) have the greatest correlation with factor 1, so these two variables are combined into factor 1. Meanwhile, the learning motivation variable (X2) and the learning facilities variable (X4) have the greatest correlation with factor 2, so these two variables are combined into factor 2.

The final step for factor arrangement is to look at the 6 Component Transformation Matrix table below.

Table 6. Component Transformation Matrix

Component Transformation Matrix

Component	1	2
1	0.746	0.666
2	0.666	0.746

Based on the table above, it can be seen that the value of Component 1 is obtained at 0.746 and Component 2 is obtained at 0.746. Because all Components are greater than 0.500, the two factors formed can be said to be appropriate in summarizing the five original variables. Of the five original variables, the Learning Motivation Variable has the greatest influence on the literacy and numeracy skills of Biology Education students at Universitas Lancang Kuning. This can be seen from the TCR value that has been obtained by each variable studied, namely Previous Education Quality (X1), Learning Motivation (X2), Social Environmental Support (X3) and Learning Facilities (X4).

Discussion

The findings of this study align with previous research on the factors influencing students' literacy and numeracy skills. The

results indicate that the quality of students' previous education was categorized as moderate (76.22%). This finding is consistent with research conducted by (Pardede, 2024), which highlighted that the quality of primary and secondary education significantly contributes to students' cognitive abilities in higher education. Students who receive a strong educational foundation tend to develop better literacy and numeracy skills, as they are already equipped with fundamental knowledge that supports advanced learning (Muliantara & Suarni, 2022).

Furthermore, learning motivation was found to be in the good category, with a Total Correct Rate (TCR) of 84.04%. This supports (Rahmawati et al., 2024) study, which demonstrated that students with high intrinsic motivation are more likely to engage in active learning processes, leading to improved academic performance. Motivated students tend to seek additional learning materials, practice problem-solving, and develop a deeper understanding of concepts, all of which contribute to their literacy and numeracy competencies (Raraswati et al, 2021). (Simamora & Akhiruddin, 2022) also emphasize that motivation plays a crucial role in students' ability to process and retain information effectively.

On the other hand, social environmental support was found to be relatively low, categorized as poor (58.63%). This result aligns with the findings of (Eka Susanti, 2023), who argued that students with minimal social support from family, peers, or faculty members often struggle in their academic journey. A lack of encouragement and guidance may lead to decreased motivation and engagement in learning activities, negatively impacting literacy and numeracy skills. (Nadjamuddin & Hulukati, 2022) socio-cultural learning theory also suggests that social interaction is essential in cognitive development, reinforcing the importance of a supportive learning environment.

Similarly, learning facilities were also found to be in the poor category, with a TCR of 55.39%. This finding supports (Arsyad, 2023) research, which emphasized that inadequate educational infrastructure can hinder students' ability to develop essential academic skills. Limited access to well-equipped libraries, laboratories, and digital learning tools can restrict students' opportunities to enhance their literacy and numeracy competencies. The OECD (2019) also reported that well-facilitated learning environments are positively correlated with students' academic success, highlighting the need for improved infrastructure to support effective learning.

Through Confirmatory Factor Analysis, this study identified two key factors that explained 60.47% of the total variance, suggesting that while previous education quality, learning motivation, social environmental support, and learning facilities significantly influence students' literacy and numeracy skills, other unexamined factors account for the remaining 39.53% of the variance. These could include teaching methodologies, individual learning styles, or students' self-regulation abilities (Muliantara & Suarni, 2022). By addressing these additional factors, educational institutions can further enhance students' academic performance and overall learning outcomes.

Conclusion

In the confirmatory factor analysis, 2 final factors were obtained which were formed from the five original variables. The variables of Previous Education Quality (X1) and Social Environmental Support (X3) were grouped into factor 1, while the variables of Learning Motivation (X2) and Learning Facilities (X4) were grouped into factor 2. The total variability of the two factors formed was 60.47% and the rest was formed from variables that were not discussed and studied in this study. The four original variables can be said to be sufficient to explain the factors that influence the literacy and numeracy skills of Biology Education students at Lancang Kuning University. Physiological variables are the most influential variables in this study. The summary of the physiological variables is 84.04% or 62 out of 74 Biology Education students agree that the Learning Motivation Factor is very important in improving literacy and numeracy skills. By

understanding the factors affecting biology education students' literacy and numeracy skills, higher education institutions can develop more effective policies, such as improving curricula, enhancing learning motivation, fostering supportive social environments, and providing better learning facilities. This study contributes to the development of optimal learning strategies to improve the quality of higher education.

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