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Basic Needs of Students in Ecology Courses: Main Factor Analysis

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Abstract

This study aimed to investigate the basic needs of students taking ecology courses. The participants were 75 students enrolled in the biology education program at the State Islamic University of Sulthan Thaha Saifuddin Jambi. The data was collected by a questionnaire consisting of 13 statements from four categories, which included the content of the material, a strong sense of learning community, thinking skills, and environmental awareness. The data was analyzed using EFA with the assistance of the SPSS application, version 23. The initial eigenvalues score from the results of EFA revealed that there were two main factors formed based on the original 13 factors. The statements that formed factor one were closely related to inquiry and self-efficacy, while those that formed factor two were closely related to environmental awareness. Based on this construction structure, factor one was labeled inquiry skills to support self-efficacy, and factor two was labeled environmental literacy. The results obtained in this study can be used as recommendations for choosing various learning techniques that can facilitate the development of inquiry skills, self-efficacy, and environmental literacy in students taking ecology courses.

Keywords: ecology courses, inquiry skills, self-efficacy, environmental literacy.

Introduction

Understanding the needs of students in ecology courses is the fundamental basis for designing and creating the courses. There is a strong need for efforts to introduce innovation in learning activities. Due to the ongoing transition in the educational paradigm, there is a strong anticipation for the enhancement of both practical life skills and the comprehension of ideas, concepts, and attitudes. The primary objective of this educational paradigm is to foster motivation and provide a chance for ecological learning to address a range of issues that are directly relevant to human existence. Certain challenges in human existence can serve as a means to cultivate students' capacity for self-discovery, enabling them to acquire proficiency in diverse ideas, conceptions, attitudes, and skills. This learning activity aims to acquaint students with ecology concepts by exposing them to real environmental settings both inside and outside the classroom. The students' capacity to access ecosystems, identify organisms, comprehend the occurring processes, and detect the influence of humans in the ecosystem will progressively develop. These tasks require advanced abilities since they involve both factual knowledge of ecological content and the capacity to perceive and understand human influences on natural processes and how they contribute to current problems (Slingsby & Barker, 2003). Ecological learning can be strategically structured to attain specific objectives that are intimately linked to attitudes and abilities, in accordance with the environmental concerns at hand, while yet maintaining focus on the fundamental principles of ecological learning (Nordlund, 2016).

Initial information is an absolute requirement to direct learning towards specific targets. This information can be used as one of the assets to plan lesson activities. In learning activities, a lesson plan is key to providing a good learning environment by ensuring constructive alignment between desired learning objectives and learning activities, as well as assessment processes (Biggs & Tang, 2011). In addition,

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maturing the learning preparation process is the responsibility of the teacher in the ethics of the teaching practiced. In line with the ethics of the teaching profession, teacher activities will become teacher behavior or culture, either low, medium, or effective, which is practiced in their work as habituation (AlKhaza'leh, 2023).

Many studies have discussed the importance of knowing the initial needs of students participating in learning activities. Piñeiro Ruiz (2009), in his research, revealed that student needs as an important part of determining learning objectives. (Derri et al. (2014) stated in their research that information about student needs is one of the important indicators in determining their performance. Nesari & Heidari (2014) confirmed that the different abilities and characteristics of students in the classroom can cause some problems for educators, therefore educators need to know the needs of students before developing a lesson plan. Sahin-Taskin (2017) revealed that to find learning activities that match the ability level of the students, educators must have preliminary information about the students they will teach. Furthermore, research conducted by Ndihokubwayo et al. (2022), who have developed a Lesson Plan Analysis Protocol (LPAP), which contains an indicator on "considering students' needs," has recommended that educators conduct self-evaluation to think about lesson plans in the next semester about this indicator. Perrin-Stowe et al. (2023), in their research, revealed that educators have the responsibility to advocate for initiatives that benefit students. In this context, the results of self-evaluation are essential for organizing to achieve learning goals. Nevertheless, to the best of our knowledge, no specific research has been found that focuses on analyzing the basic needs of students in ecology courses.

This research attempted to reveal the basic needs of students who attended ecology lectures. Referring to the main principles of learning in higher education, two main components must be considered: (i) how students learn (how cognitive processes function in individuals) and (ii) how educators can utilize the learning process to improve student teaching (Ambrose et al., 2010). In line with these principles, the results of the information obtained in this study will be used to direct learning activities that match the needs of students. Furthermore, the information will be used to make various changes in ecology learning activities by including new elements or incorporating new ideas and techniques into learning activities. The aim is to improve cognitive processes and skills and enhance student learning. On the other hand, choosing new techniques or strategies requires sufficient knowledge because it has been proven that there will be difficult challenges that educators will face in the process (Burrow, 2018). These problems can be overcome, especially if educators are given support to explore the knowledge or information needed to select and use the teaching strategies they will use (Elliott et al., 2016). Therefore, from the results of this study, we try to recommend a learning strategy that has the opportunity to be used according to student needs. The recommendations that we provide are certainly based on the literature that we have obtained.

Methods

Research design

A quantitative descriptive approach was used as the primary methodology to collect objective and quantifiable data for statistical analysis. To process the collected data, the exploratory factor analysis (EFA) technique was utilized. EFA is a statistical method that aims to identify the underlying structure in large data sets (Tabachnick & Fidell, 2013). By using EFA, this research aims to reduce the number of factors by exploring and detecting the structure in each factor's relationship. This will enable the identification of smaller factors that can explain the pattern of correlation between the construct factors used.

The main purpose of applying EFA In this study is to identify the underlying structure of students' responses to various variables or construct factors. These factors include the content of the material, strong feelings within the learning community, thinking skills, and environmental awareness. By identifying and formulating significant factors, EFA will help us better understand the specific dimensions that influence students' learning experiences. These results will be useful in decision-making and formulating more effective educational strategies based on the factor structure obtained from the analysis results (Hair et al., 2019) ultimately leading to a better learning experience for students.

Population and samples of the reasearch

The sampling process in this study was conducted by selecting seventh semester students at Sulthan Thaha Saifuddin Stat0e Islamic University Jambi who had completed the ecology course as the target population. A number of 75 students were selected to be the sample, representing the entire population relevant to the research objectives. The selection of the sample was determined based on specific inclusion criteria, defined as students who had attended and completed the ecology course, to ensure that the data collected was valid and reflected authentic experiences related to the course. The saturated sample method was used in this context (Creswell & Creswell, 2017), where the entire population that met the inclusion criteria was sampled, so that the results of the study are expected to provide a comprehensive and in-depth picture of the phenomenon under study.

Data collection tools

The data were collected in December 2023 through a verified questionnaire that had been examined by professionals. The respondents were directly given the questionnaires to fill out, and they constituted the entire population involved in this research. The questionnaire consisted of 13 items employing a Likert scale with four levels of agreement - strongly agree, agree, disagree, and strongly disagree - to avoid neutral responses. The scale levels were ranked from 4 (the highest level of agreement) to 1 (the lowest level of agreement). The utilization of four scales aims to discourage respondents from adopting a neutral stance (Singleton & Straits, 2009). The responses were analyzed to extract the primary components and provide useful information for researchers to diagnose student requirements in ecology lectures. The constructs of the statements in this questionnaire were developed by adapting the principles of active learning based on the opinion of (Ambrose et al., 2010) and then adapted to learning in the ecology classroom. The construction of the statement consists of the content of the material, strong feelings of learning community, thinking skills, and environmental awareness.

Data analysis

The data analysis process involved several main steps, which were systematic and structured. The process of data analysis begins with data collection through questionnaires that have been filled out by respondents, who are students who have completed an ecology course at Sulthan Thaha Saifuddin Jambi State Islamic University. Before proceeding to the EFA stage, it is important to conduct validity and reliability tests on the instruments used in the study (Field, 2013). The validity test aims to ensure that the data collection instrument is able to measure what should be measured so that the results obtained can be interpreted appropriately. On the other hand, reliability tests are conducted to ensure the consistency of measurement results if the instrument is used repeatedly under similar conditions (Creswell & Creswell, 2017). The technique often used in reliability testing is Cronbach's alpha, which measures the internal consistency of an instrument. Meanwhile, the validity test refers to the "Corrected Item-Total Correlation" score obtained from the analysis results. This process is essential to ensure the integrity of the data to be analyzed and to ensure that the conclusions drawn from EFA are valid and reliable (Tabachnick & Fidell, 2013).

Subsequent EFA data analysis began with a data suitability check. The aim is to ensure that the data is suitable for factor analysis. Checks to assess the feasibility of data in factor models are carried out by testing sample adequacy, such as Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity (Hair et al., 2019). The second analysis looks at the sampling adequacy measure (MSA) score to determine which statements are appropriate to use. The MSA value of each statement analyzed must be greater than 0.50 to indicate that all statements are suitable for use to determine the main factor (Hair et al., 2019). The next EFA analysis is factor extraction, which determines the choice of extraction method, in this study using Principal Component Analysis (PCA). The number of factors to be extracted can be determined through the initial eigenvalue score (score more than 1) or through the scree plot displayed (Field, 2013). After the factors are extracted, the next step is to rotate to facilitate factor interpretation (Hair et al., 2019). In this study, using varimax rotation, which is an orthogonal rotation, the aim is to sharpen the factor structure and facilitate interpretation (Field, 2013). The analysis results obtained from SPSS are interpreted by looking at the factor loading on each variable (Hair et al., 2019). Variables with high loading on a particular factor indicate that the variable has a significant contribution to that factor. Then, the naming of the new factor is identified based on the characteristics of the variables that contribute to the new factor, resulting in a logical and theoretical interpretation (Tabachnick & Fidell, 2013).

Results and Discussion

Exploration Factor Analysis

Validity and reliability tests in this study are needed to determine the validity of the instrument as well as the consistency and stability of these instruments. The results of the validity test refer to the "Corrected Item-Total Correlation" score (Table. 1). This analysis comes from the reliability test, and the result shows that the score of each statement is greater than the R table score, where the Table R score for 75 students is 0.227 at a significance level of 0.05. The results are also in line with the "Pearson Correlation" score analysis, which shows that the total score of each statement is higher than the R Table score (0.227).

Likewise, the significance score (2-tailed) of each statement is less than 0.05. The reliability test results obtained for the Cronbach's alpha score of thirteen statements are 0.87, where this score is greater than 0.06. The reliability test results indicate that all statement items tested are reliable or consistent. The results of the statistical output of the reliability test in Table 1, especially the "Cronbach's alpha if Item Deleted" section, show the value of each statement is greater than 0.06. The results of this analysis indicate that each statement is reliable (Sujarweni, 2014).

TPrior to conducting EFA, it is necessary to perform some preliminary analysis. The first assessment is the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO MSA) analysis, which evaluates the adequacy of the

Table 1: Output of reliability test re sults.

Statement Sequence	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Statement 1	.446	.877
Statement 2	.333	.887
Statement 3	.689	.866
Statement 4	.595	.869
Statement 5	.558	.871
Statement 6	.575	.870
Statement 7	.563	.871
Statement 8	.805	.860
Statement 9	.658	.867
Statement 10	.645	.868
Statement 11	.756	.860
Statement 12	.713	.863
Statement 13	.334	.889

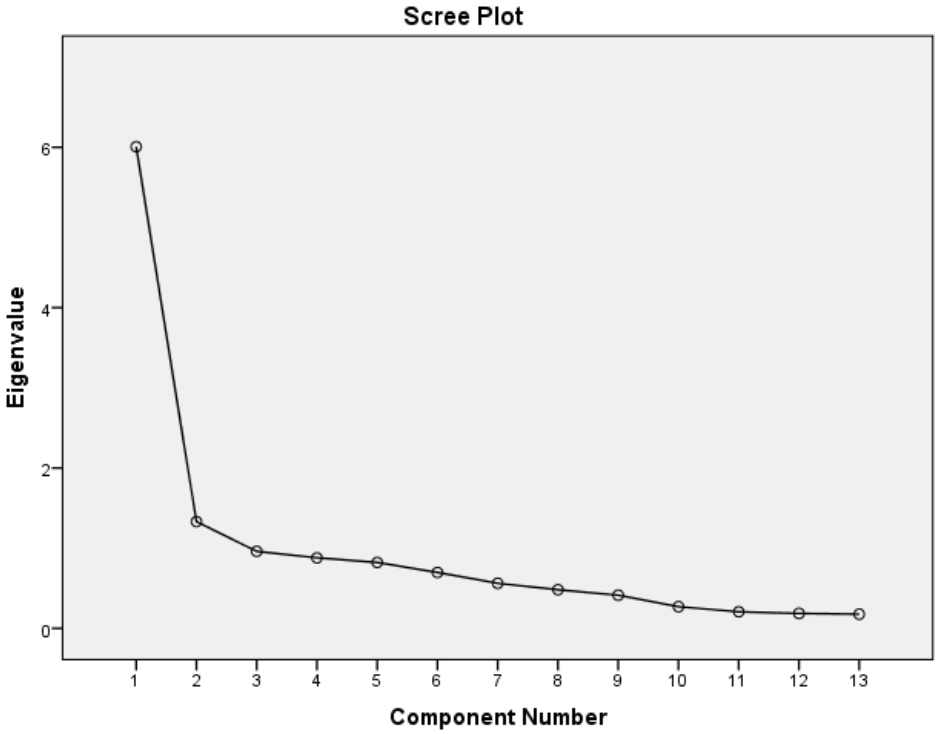

Figure 1. Scree plot of exploratory factor analysis

sample. Additionally, the significant score of Bartlett's Test of Sphericity is considered. The results of the analysis in the first part show that the KMO MSA value is 0.85, which is greater than 0.50. While the Bartlett's Test of Sphericity (Sig.) value is 0.00, this is smaller than 0.05. The results of the analysis in the first part have met the specified requirements. The second analysis is by looking at the measure of sampling adequacy (MSA) score to determine which statements are suitable for use. The MSA value of each statement analyzed is greater than 0.50, indicating that all statements are suitable for use to determine the main factor. So overall, the results of the pre-requisite analysis in this study show that each criterion

of each analysis has met the requirements for factor analysis. The results that have been obtained indicate that the analysis process can be continued.

The EFA revealed that the calculation results for thirteen statements show that two factors have a value greater than one. This indicates that two main factors were involved in the calculation results. This result is also following the examination of the scree plot in Figure 1, which clearly shows that the points of factor 1 and factor 2 are above the number 1.

The process of determining the main factor or main component starts by looking at the score of the "initial eigenvalues" presented in Table 2. The total statements analyzed in this study totaled 13 items, indicating that there were 13 components formed, and then the components were categorized as 13 original factors. The total score of "Initial Eigenvalues" for the 13 original factors shows that the score of factor 1 and the score of factor 2 are greater than score 1, and the total score of "Initial Eigenvalues" from factor 3 to factor 13 is less than score 1. Based on predetermined statistical provisions (Hair et al., 2019), these results position factor 1 and factor 2 as the main factors.

The percentage variation of components 1 and 2 shows a larger score than the percentage variation of the other variables. The total data variation for components 1 and 2 is 56.451%, as presented in the column of "cumulative percentage" (Table 2). This illustrates that more than half of the data variation is located in these two components. The percentage variation of component one shows that more data from respondents fill this component, which is 46.208%, indicating that component one is a greater determinant of the calculation results in this study. While the second component has a percentage variation of 10.243%, the distribution of data is relatively smaller when compared to component one, but this result is greater than other variables.

TThe correlation score of 13 statements with factors 1 and 2 can determine the position of each statement on the factors formed. The results of the calculation of the correlation score between the 13 statements and the two factors formed can be seen in Table 3.

In order to establish whether each statement belongs to Factor Group 1 or Factor Group 2, it can be determined by looking at the largest correlation score between the statement and the factor formed (Hair et al., 2019). According to Table 3, statements 1, 3, 7, 8, 9, 10, 11, 12, and 13 have higher scores on factor 1, whereas statements 2, 4, 5, and 6 have higher scores on factor 2. The factor analysis results indicate that statements 1, 3, 7, 8, 9, 10, 11, 12, and 13 belong to factor group 1, while statements 2, 4, 5, and 6 are part of factor group 2. The structure of this statement is displayed in Table 4.

The factor loading scores are presented in Table 4 is a score that shows the strength of the correlation of the original factor with the factor formed. Based on Hair et al. (2019) significance level of factor loading for 75 respondents, the score must be greater than 0.65. Based on these criteria, the factor loading score in the table above illustrates that Statements 1, 2, 3, 4, and 13 have a low correlation with the factors formed. This is because the factor loading score of the five statements is under 0.65. However, the "component transformation matrix" score of the two factors formed is

Table 2: Initial Eigenvalues on the formed components

	Initial Eigenvalues		
Factor	*Total*	*% of Variance*	*Cumulative %*
1	6.007	46.208	46.208
2	1.332	10.243	56.451
3	.960	7.388	63.839
4	.880	6.770	70.609
5	.822	6.325	76.934
6	.698	5.369	82.303
7	.563	4.327	86.630
8	.483	3.713	90.343
9	.414	3.184	93.527
10	.270	2.079	95.605
11	.208	1.597	97.203
12	.186	1.433	98.636
13	.177	1.364	100.000

Table 3: The correlation score of the statement with the factor formed

	Correlation Score	
Statement Sequence	*Faktor 1*	*Faktor 2*
Statement 1	.391	.345
Statement 2	.169	.427
Statement 3	.631	.413
Statement 4	.443	.517
Statement 5	.093	.909
Statement 6	.150	.885
Statement 7	.751	.120
Statement 8	.820	.350
Statement 9	.686	.342
Statement 10	.739	.220
Statement 11	.653	.510
Statement 12	.759	.303
Statement 13	.523	-.022

Table 4: Construct statements for the formed factor

Construct			Factor	
		Statements	*1*	*2*
Content of the material	1.	In general, the Ecology courses that I had studied support the improvement of knowledge and competencies that I expect.	.391	
	13.	The lectures that had been conducted were active learning using a contextual learning approach.	.523	
Strong feelings within the learning community	3.	The Ecology courses I had taken made me feel comfortable with the community and the place where I studied.	.631	
	11.	The Ecology courses I had taken already helped me to build my confidence in conducting investigations and research.	.653	
	12.	The Ecology course I attended encouraged me to expose the application of the scientific method that I had used.	. 759	
Thinking skills	7.	The Ecology course that I took helped me to explore my understanding and ability to investigate cases in depth and detail.	.751	
	8.	The Ecology course that I took helped me to do good reasoning.	.820	
	9.	The Ecology course that I took helped me to do a good argument analysis.	.686	
	10.	The Ecology course I took helped me to develop good decision-making and problem-solving skills.	.739	
Environmental awareness	2.	I was able to understand well when the Ecology lecture was related to environmental problems.		.427
	4.	The lectures helped me gain knowledge and understanding about the environment.		.517
	5.	The lectures that have been conducted, helped me raise awareness about my role for the environment and my role for the surrounding community.		.909
	6.	The lectures that have been conducted, helped me to develop a caring attitude towards the environment.		.885

greater than 0.5, amounting to 0.8 for each factor. In EFA, the "component transformation matrix" is used to prove the correlation score of the factors formed (Santoso, 2015). So based on the "component transformation matrix" score, it can be stated that the two factors formed are appropriate in summarizing the 13 statements analyzed.

Main Components of Factor Analysis Results

The results of the EFA identified two main components as new factors. Based on the score of the "Component Transformation Matrix," the factors formed have fairly good strength in summarizing the 13 statements on the questionnaire used in this study. However, five statements have a low correlation with the factors formed. This indication is shown by the factor loading score obtained from the calculation results (Table 4). The factor loading scores of these five questions have not met the criteria of the minimum standard score for a significance level (α) of 0.05 and a power level of 80% at 70 respondents, which requires the score to be greater than 0.65 (Hair et al., 2019). The low scores of these five statements have been identified since the initial analysis, before moving on to factor analysis. However, this score is not too significant in providing influence, so it is still included in the analysis with the purpose that the variations formed can be seen, in addition to making it easier to determine the new factors formed (Beck & Blumer, 2016).

The two new factors in this study are the main factors formed by the construction of statements from the questionnaire. The composing statement assembles each ingredient in a random sequence. The construction of the learning community's strong feelings, thinking abilities, and material content all contribute to factor 1. The creation of environmental awareness-related statements gave rise to factor 2. The statement construction that has a very strong correlation with the factor it forms is the statement derived from the thinking skills construction. All statements from this construct have a correlation score greater than 0.65. In contrast, all statements derived from the material content construct have a weak relationship to the factor formed, with the acquisition of calculation results for each statement being smaller than 0.65. Meanwhile, for the other two constructs, there are variations in the relationship between each statement and its factor. However, statements that have a correlation

value above 0.65 are representative of describing each factor. So based on the results, the two main factors formed in this study have been compiled from statement components that are strong enough and can provide an overview of the factors formed, even though statements that have a low correlation are removed.

By analyzing the structure of the sentences comprising factor one and factor two, it becomes evident that factor one is strongly associated with self-efficacy and inquiry, whereas factor two is tightly linked to environmental awareness. The identification process involves dissecting the statements on factor one, where these statements influence respondents' confidence in the abilities and skills they have developed or acquired as a result of inquiry activities. Meanwhile, the description of statements in factor two is more dominant in directing respondents' attitudes towards the environment. The construction can be organized in such a way that labels can be assigned to each factor. Factor one can be designated as the Inquiry Skills to Support Self-Efficacy Factor, while factor two can be designated as the Environmental Literacy Factor.

The formulation of the label for factor one refers to Human-Vogel & Vogel (2015) insight on self-efficacy. They convey that self-efficacy reflects a belief in the ability to exert control over one's motivation, behaviour, and social environment. This view is consistent with statements 3 and 11. Gormally et al. (2012) wrote an article that talked about scientific inquiry skills. These skills are related to two main parts of science literacy: a) recognizing and analyzing the use of inquiry methods that lead to scientific knowledge; and b) collecting, analyzing, and making sense of scientific data and information. This description corresponds to statements 7, 8, 9, 10, and 12. Furthermore, the formulation of labels for factor two refers to the statement of Kaya & Elster (2019), which reveals that environmental literacy is a form of responsibility and optimism for the environment that leads to the development of environmental behaviour. This opinion is consistent with statements 2, 4, 5, and 6. Based on the analysis results obtained in this study, it is clear that the basic need for students to take ecology courses is to improve their inquiry skills, self-efficacy, and environmental literacy.

Conclusion

The EFA conducted in this study identified two main factors derived from the initial set of 13 factors. The "factor loading" score, which shows the correlation strength of the original factors with the main factors formed, has illustrated that the original factors 1, 2, 3, 4, and 13 have a low correl0ation with the two main factors formed. Conversely, the original factors 5, 6, 7, 8, 9, 10, 11, and 12 have a strong correlation with the two main factors. Nevertheless, the "component transformation matrix" score of the two main factors formed is appropriate for summarizing the original 13 factors. Based on the construction of statements on the original factors, it can be identified that factor one is closely related to self-efficacy and inquiry, in contrast to factor two, which is closely related to environmental awareness. Following the construction arrangement formed in this study, we can formulate a label for each factor, where the first factor is the inquiry skills to support the self-efficacy and the next factor is the environmental literacy.

Recommendation

The results of the analysis obtained in this study provide information that two main factors become the basic needs of students in participating in ecology learning activities: inquiry skills to support self-efficacy and environmental literacy. Referring to the main principles of learning in higher education and the research results obtained, we recommend conducting research using citizen science projects as one of the techniques applied in ecology learning. Citizen science projects have specific characteristics that can support the development of science inquiry skills (Becker-Klein et al., 2016), improve attitudes, self-efficacy, and motivation (Phillips et al., 2018), and improve students' environmental literacy (Jakositz et al., 2022). But more importantly, citizen science projects have a close relationship with various ecological and environmental studies. Hence, it will be easier to apply it to ecology learning.

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