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Level analysis knowledge and the application of STEM by lecturers in order to develop the STEM education

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Abstract

STEM education is currently one of the most updated topics in line with 21st century learning. Technology-based education is integrated in science, engineering and mathematics. Analysis is needed to see the development of educational activities, especially in the field of STEM education. However, according to TIMSS and PISA, there is still a lack of human resources who master the STEM field. Efforts to advance the development of STEM education are carried out using analysis through the distribution of assessments. In this case the analysis includes two aspects, namely the level of knowledge and the application of the STEM method. The comparison of the two aspects is based on the accumulative data of lecturers' assessments. This study aims to analyze the level of knowledge and the application of the STEM method used as an effort to develop STEM education. This type of research is mixed research. Research that applies two combinations of qualitative and quantitative research. Quantitative research to determine the value of the analysis between variables. Qualitative research to strengthen quantitative results. The results of this study that knowledge about STEM in the high category is 80% while the application of the STEM method is in the low category with a percentage of 25%. The application of the STEM method is hampered by the lack of STEM education methods owned by lecturers.

Keyword: Develop, STEM Education, Applocation, Knowledge;

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1. Introduction

STEM education is currently one of the most updated topics in line with 21st century learning, an integrated approach that can increase students' problem-solving capacity by involving them in systematic investigations that require cross-disciplinary knowledge (Hong, 2019). STEM education has been widely developed in several countries in the world, namely America, Europe, and Asia. Indonesia is one of the countries that has begun to carry out educational reforms by implementing STEM education in learning in schools and universities (Suwarma, 2018). The application of STEM can help develop knowledge, train students in solving real problems in everyday life based on investigations and can help students to create and innovate new knowledge (Margot, 2019; Suebsing, 2021). In addition, the application of STEM can train students to innovate by including critical thinking, able to solve problems, creative and innovative, and able to communicate and collaborate, skilled in using media, technology and communication (Ultay, 2020; Ejiwale 2013).

The success of the application of STEM in learning is strongly influenced by the ability of educators (teachers and lecturers), especially lecturers who teach ecophysiology courses. The ecophysiology course is a course that studies the influence of environmental factors on plant life, so it is closely related to investigations and measurements that are in accordance with STEM education. The suitability of ecophysiology learning methods will affect the level of understanding of students. Like the research of Bialang (2016) and Suwono (2017) that the application of several learning methods in ecophysiology learning gets different percentage values, ecophysiology learning with the right method has a higher cognitive value. In another study by Saputri (2019), the learning method used has a major influence on the success of learning, so that the mastery of the learning method possessed by the educator will affect the success rate of a lesson. Based on the explanation above, improving the quality of education in Indonesia has been carried out with various efforts. However, based on TIMSS and PISA, there are still low human resources who master the STEM field, including in Indonesia, so efforts are needed to develop STEM education in Indonesia. One of the efforts to advance the development of STEM education is carried out by using analysis through the dissemination of STEM assessments.

Assessment is useful for inclusive assessments to ensure the implementation of STEM education can run well. Assessment is very helpful in improving the curriculum, teaching quality, and learning methods (Wahono, 2019). Based on the results of the assessment data, it can be useful to reveal the application of STEM education in the education sector. Assessment in education is a very complex, indispensable and very important issue. An assessment that can later determine the level of testing carried out (Scineider, 2017). Through the assessment, an assessment of the development of STEM education can be carried out to regulate and see the acceptance and progress of STEM among educators including lecturers (Wahono, 2019). The assessment used includes two aspects of the assessment, namely the level of knowledge and the application of STEM. Knowledge can be interpreted in various aspects. In this analysis, the lecturer's knowledge includes propositional knowledge and case knowledge. Propositional knowledge is defined as a view of something that can be true or false (Craig, 2012). Case

knowledge which means knowledge in teaching and learning practices in this case in STEM education. By looking at proportional knowledge can be used to examine how the implementation of teaching and learning.

Several previous studies tried to identify the perceptions of science teachers who teach in junior high and high schools in supporting the development of STEM education and the difficulties of implementing STEM (Khuyen (2020), Wahono (2019)). The researchers used an instrument in the form of questions related to STEM education for science teachers. However, there are still very limited data on the knowledge and application of STEM lecturers in the field of science in universities. This study aims to analyze the level of knowledge and application of STEM used as an effort to develop STEM education.

2. Methodology

This research uses mixed research. Mixed research is research that applies two combinations of research, namely qualitative and quantitative research. Qualitative research is a method to examine the condition of a natural object. Quantitative research is a method for proving previously established hypotheses and looking for relationships between variables. This research method uses descriptive method. Descriptive research method has a goal to analyze and display data in a detailed and accurate form. Methods of data collection using interviews and questionnaires. The interview used purposive sampling technique. Purposive sampling technique is a sampling technique that uses criteria that have been selected by the researcher. The criteria for selecting the sample in this research used the inclusion sample selection criteria. Inclusion criteria are the criteria for the sample that the researcher wants based on the research objectives. The sample criteria selected in this study were lecturers who taught ecophysiology courses. The following Figure 1 is a purposive sampling technique carried out in this study.

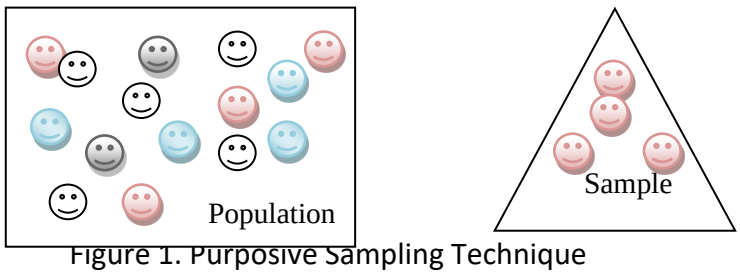

Figure 1. Purposive Sampling Technique

Based on Figure 1. the purposive sampling technique in this research is data collection of lecturers who teach ecophysiology courses which are then used as research samples. Researchers conducted interviews and distributed questionnaires to lecturers who had been assigned as samples.

The respondents of this research are university lecturers who teach ecophysiology courses. Respondents in this study were 5 lecturers, namely lecturers who taught ecophysiology courses at several universities in Jember Regency, East Java, Indonesia. Specifically, respondents were divided into categories of gender, level of education and teaching experience which are described in Table 1. as follows:

Variable	Category	Total	Percentage
Gender	Male	2	40%
	Female	3	60%
Level of education	Master	4	80%
	Doctoral	1	20%
Teaching experience	<5 years	3	60%
(Ekofisiologi)	>5 years	2	40%

Table 1. Demographic Data

The research variable that will be measured in this study is to analyze the level of knowledge and application of STEM. Research variable data obtained from interviews and questionnaires with instruments that match the desired variables. The instrument item looks at the STEM Education Quality Framework. The questionnaire instrument was divided into two parts, namely the STEM knowledge section and the STEM application. The application of STEM is divided into several sub-sections, namely Science-Technology (ST), Science-Engenering (SE), Science-Mathematics (SM), Science-Technology-Engenering (STE), Science-Technology-Mathematics (STM), Science-Technology -Engenering-Mathematics (STEM). Questionnaire items contain items to access respondents' data about STEM knowledge and STEM application in the form of several questions with a total of 27 questions. One example of a question to get information about STEM knowledge is "Do you know the strengths and weaknesses of STEM?" Furthermore, an example of a question to obtain information about the application of STEM is "Do you teach ecophysiology lessons with electronic devices as a support?" The instrument uses a type two scale, namely Yes/No.

Analysis of the instrument reliability level score using the Cronbach Alpha method. The analysis was carried out using the data from the questionnaire test results from filling in the respondents. Reliability test is a marker that can show the extent to which the measuring instrument in this case the questionnaire can be trusted. The following are the results of the reliability test: Knowledge of Science-Technology-Engineering-Match (STEM) (0.704) and application of STEM with each sub: Science-Technology (ST) (0.656), Science-Engineering (SE) (0.705), Science - Match (SM) (0.637), Science-Technology-Engineering (STE) (0.643), Science-Technolgy-Match (STM) (0.708), Science-Engineering-Match (SEM) (0.672), STEM (0.635). From these results, the Cronbach Alpha value in each section gets a value above 0.60. The overall Cronbach's Alpha value is 0.684. The reliability scale test was evaluated using Cronvach Alpha which means that a value greater than 0.6 is considered acceptable or consistent (reliable). Furthermore, the validation of the needs and content questionnaire was carried out by two experts in the STEM field. The average result of the validation level of suitability of the two experts was 86.5%. From the results of the percentage, it means that the instrument is valid and can be used for data collection.

Data analysis in this study used descriptive methods and data comparison with Microsoft Excel which aims to obtain data on differences in knowledge of the STEM approach and the application of the STEM method by gender, level of education and teaching experience.

3. Result

The following are the results of research obtained in this study consisting of two aspects, namely Knowledge of the STEM Approach and Application of the STEM approach to learning.

3.1 STEM Knowledge

The following Figure 1. is the result of the questionnaire data needs related to knowledge about STEM.

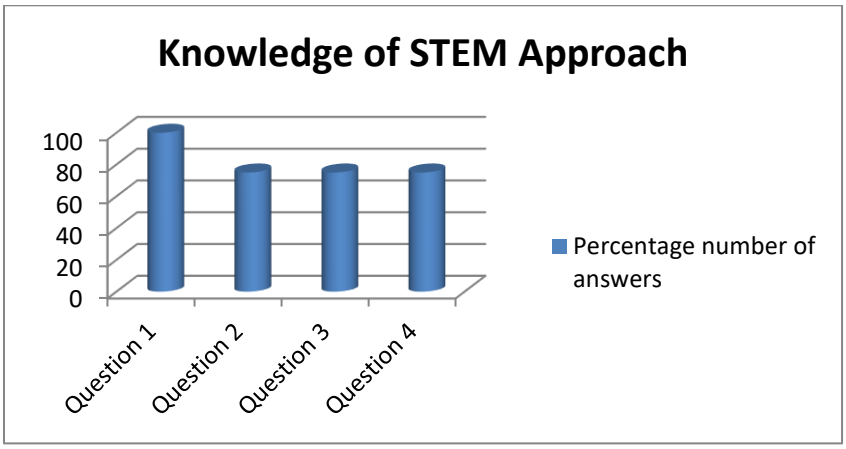

Figure 1. Knowledge of STEM Approach

Based on Figure 1, it can be seen that in the first question, namely "knowing the abbreviation of the term STEM" the results of the percentage of answers are 100%, which means that all lecturers understand what STEM stands for. In the second question, namely "knowing that STEM learning is not a learning method or model" the percentage of answers is 75% which means that some lecturers do not understand that STEM is not a learning method or model. In the third question, namely "knowing the advantages and disadvantages of STEM" the percentage of answers is 75%, which means that some lecturers still do not understand the advantages and disadvantages of STEM. The fourth question is "STEM learning is an integration of science, technology, engineering, and mathematics, or at least consists of two fields of science and the perspective of STEM learning is the existence of a bond that emphasizes the problem." Getting an answer percentage of 75% which means that some lecturers do not agree with the STEM understanding statement.

3.2 Application of STEM in Learning

The results of the analysis of the STEM application data are divided into two parts, namely the results of the questionnaire data on the overall STEM application needs or the average of all respondents and the results of the STEM application data according to 3 aspects of comparison, namely gender, education level, and teaching experience.

a. The following Figure 2. is the result of the questionnaire data needs about the application of STEM in overall learning from research respondents.

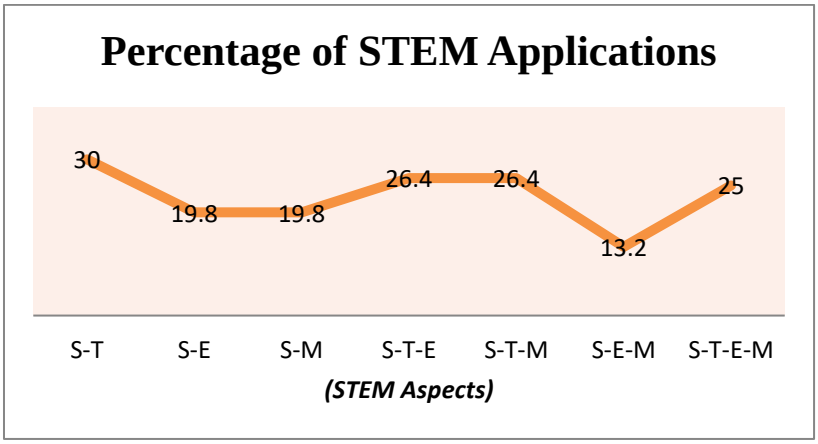

Figure 2. Application of STEM in Learning

Based on Figure 2, it can be seen that there are several questions that are divided into several aspects. The first aspect (S-T) in the form of 4 questions on the application of science and technology in ecophysiology learning gets a 30% answer percentage, which means that the application of science and technology in learning is still low. The second aspect (S-E) consists of 3 questions on the application of science and engineering in ecophysiology learning with a percentage of answers of 19.8%, which means that the application of science and engineering in learning is still very low. The third aspect (S-M) in the form of 3 questions on the application of science and mathematics in ecophysiology learning with a percentage of answers of 19.8%, which means that the application of science and mathematics in learning is still very low. Aspects (S-T-E) in the form of 3 questions on the application of science, technology and engineering in ecophysiology learning with an answer percentage of 26.4%, which means that only a small number of lecturers have applied science, technology and engineering to learning. The fifth aspect (S-T-M) consists of 3 questions on the application of science, technology and mathematics in ecophysiology learning with a percentage of answers of 26.4%, which means that 73.6% of lecturers still have not applied science, technology and mathematics to learning. The sixth aspect (S-E-M) consists of 3 questions on the application of science, engineering and mathematics in ecophysiology learning with an answer percentage of 13.2%, which means that most of the lecturers have not applied science, engineering and mathematics to learning. The seventh aspect (S-T-E-M) consists of 4 questions on the application of science, technology, engineering and mathematics in ecophysiology learning with a percentage of answers of 25%, which means that only 25% of lecturers have applied science, technology, engineering and mathematics to learning.

b. The following Figure 3. is a graph of the results of the questionnaire data needs on the comparison of the application of STEM when viewed from 3 different aspects, namely gender, level of education and teaching experience.

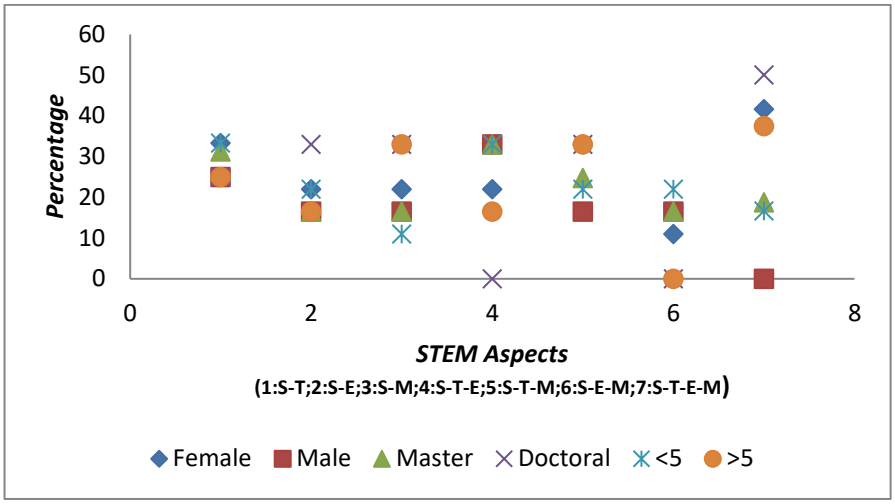

Figure 3. Comparison of STEM Applications by Gender, Level Education, and Teaching Experience

Based on Figure 3, it can be seen that in the application of STEM according to gender comparison there are two aspects of the application that are significantly different, namely in the first aspect of the application of S-T-E, there is a difference of 15% with the value of the application of STEM in males being higher in the S-T-E aspect. The second aspect of the application of S-T-E-M has a significant difference of 40% with the value of STEM application in women being higher in the S-T-E-M aspect. But in the five aspects of STEM implementation between women and men there was no significant difference. Furthermore, the application of STEM according to the comparison of education levels can be seen that in the aspects of S-T, S-E, S-M, S-T-M there is no significant difference with the average percentage of application of 35%. Significant values occur in the aspects of S-T-E, S-E-M and S-T-E-M with a percentage difference of 30%. Then the application of STEM according to the comparison of teaching time can be seen that the five aspects of S-M, S-T-E, S-T-M, S-E-M and S-T-E-M have a significant difference with an average percentage of 20%. In the aspect of S-T and S-E have almost the same percentage value.

4. Discussion

STEM education is a very complex learning approach that integrates four elements in learning, namely science, technology, engineering and match. STEM education can train students' learning skills, making students think critically, creatively and innovatively in understanding the concepts of learning materials. STEM education has been introduced by the SEAMEO Center for QITEP in schools and universities since 2013 through teacher training activities and other policy forums (David, 2014). Based on the results of research on STEM knowledge of ecophysiology lecturers, each question related to STEM knowledge as a whole has an average percentage of 81% which means that knowledge of STEM on ecophysiology lecturers is quite high. In the interview, each lecturer can answer and explain what STEM is, knowing the meaning, advantages and disadvantages of STEM. Based on the data above, the lecturer's knowledge of STEM education is sufficient which is expected to be applied during learning. But the results of the STEM application data show that the application of STEM in learning is still very low with a percentage of 25%. When viewed from the results of the data on every aspect of STEM, the results of the application are still low with a percentage below 30%. From this explanation, the application of STEM in ecophysiology courses is still very low.

Furthermore, the comparison of the application of STEM with gender according to the results of the study that four aspects have a percentage value of application that is not much different and

only two aspects have a percentage difference of 15%, so that the gender factor does not affect the level of implementation of STEM implementation in learning. This is in line with Shah's research (2018) that there is no significant effect of gender on the teaching ability of educators. Basically every educator has the same responsibility to educate students. Then the comparison of the application of STEM with the level of education has a difference in the average percentage of 35% which means that the education level factor has a small effect. The results of this study are in line with the research of Idris (2019) that the level of education has a significant influence on the teaching performance of educators. Educators with higher levels of education tend to have more effective learning techniques and methods for learning success. Furthermore, the comparison of STEM with teaching length has a percentage difference of 20% which means that length has little effect on the implementation of STEM implementation in learning. In the research of Meiderick (2016) and Idris (2019) that teaching experience has a significant effect on the teaching ability of educators.

5. Conclusion and Recommendation

Based on the results and discussion, it is concluded that the knowledge of ecophysiology lecturers about STEM is high, but the application of STEM in learning is still very low. The application in every aspect of STEM is also still low. If viewed by gender, it has no effect on the level of STEM implementation. In contrast to the level of education and length of teaching affect the level of application of STEM. Lecturers who have a higher education level have a higher STEM application value, as well as the length of teaching factor. Because the application of STEM is still low, further research is needed to increase the application of STEM among universities.

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