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Research Article

Performance assessment to measure creativity through STREAM approach

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ABSTRACT

Learning online during pandemic COVID-19 must still accommodate creativity. This study aimed to identify the level of student creativity using the STREAM (Science-Technology-Religion-Engineering-Arts-Mathematics) approach. It was conducted on an online practicum in the Plant Anatomy course. The purpose of this study was to identify the level of student creativity in various indicators of creativity through a performance assessment of the product of the practicum report. The static-group comparison design was used as the research design. The target population is the fourth-semester student in the Department of Biology Education. The samples were chosen using purposive sampling, determining class IV-A (39 students) as a regular class and class IV-C (38 students) as intervention one. The research was equipped with creativity performance tasks, rubrics with a scoring of practicum reports' performance assessments, and field notes. Each student designs and makes one of the anatomical structural models of roots, stems, or leaves. The practicum report was used to identify their level of creativity. The data were analyzed by calculating the creativity level percentage in a qualitative descriptive manner. The results showed that the creativity level of the intervention class is excelling (57.89%), while the regular class the emerging (58.79%). The STREAM approach provides a better level of creativity.

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INTRODUCTION

The 21st century skills include higher-order thinking skills (Binkley et al., 2014; Haviz et al., 2018; Patresia et al., 2020; Zubaidah, 2019). Students expect to have higher-order thinking skills through learning. The student needs to master technology to cope with the rapid development of this century (Rachmawati et al., 2018; Zubaidah, 2019). The learning approach that supports this competence is STEM (Science-Technology-Engineering-Mathematics) which is in its development to become STEAM (Science-Technology-Engineering-Arts-Mathematics). Learning using the STEAM approach helps students solve a problem, imagine and think innovatively, prioritize artistic aspects, be creative in understanding science content, and create technology or products (Anindya & Wusqo, 2020; Conradty & Bogner, 2019; Henriksen, 2014; Oner et al., 2016; Sasson et al., 2018; Zubaidah, 2019). The art aspect of STEM provides opportunities for students to be creative. Creativity is a part of 21st-century skills (Basham & Marino, 2013; Bybee, 2010; Care, 2018; Rustaman et al., 2018). It is stated in Indonesian National Qualifications Framework (Kerangka Kualifikasi Nasional Indonesia – KKNI) in the field of research that students must be able to innovate. The ability to innovate is a sign of the existence of creative thinking (Dong et al., 2021). Higher education aimed to produce creative intellectuals to increase the nation's competitiveness in facing globalization. It is stated in Indonesia's Law No. 12 of 2012 concerning higher education (Agustina et al., 2019). Creativity can be measured using fluency, flexibility, originality, and elaboration indicator. Fluency is the ability to express various ideas fluently. An indicator of flexibility is the ability to think of different ways to solve problems. The originality can be demonstrated by problem-solving skills using their ideas. The elaboration is the ability to develop and enrich other ideas (Agustina et al., 2019; Rustaman et al., 2018; Torrance, 1977). Creativity can be promoted through science learning (Cheng, 2011; Daud et al., 2012; Gomes & McCauley, 2021; Yuhanna & Retno, 2016), such as STEAM (Allina, 2018; Anindya & Wusqo, 2020; Conradty & Bogner, 2019; Thuneberg et al., 2018; Wandari et al., 2018).

Creativity can provide benefits for humanity and help students in their life. Creativity must follow Islamic principles and sharia based on the Tawheed aspect (Agustina et al., 2019; Al-Karasneh & Saleh, 2010; Daud et al., 2012). Thus, the developed learning approaches that can provide creativity must be related to aspects of religion. The religion (R) aspect is added to the STEAM approach to become STREAM (Agustina et al., 2020). The addition of religious aspects can form piety and *aqhlakul kareemah* in students. In addition, the characteristics of 21st-century learning can apply values to shape students' personalities (Zubaidah, 2019). Biology Education at Sunan Gunung Djati State Islamic University is located in an Islamic Religious Higher Education institution and has the paradigm of "Revelation Guiding Science" (Wahyu Memandu Ilmu/WMI). There are two indicators of the aspect of religion, including core competency one (KI-1) and WMI Paradigm. The KI-1 indicators are: respecting, appreciating, and practicing the teachings adopted by religion (Agustina et al., 2020). The WMI paradigm states that science will not conflict with religion (Darmalaksana, 2021). The religion, in this case, is Islam. The result of previous studies regarding the STREAM approach can provide students' creativity in the content of Applied Biology and Traditional Biotechnology material. This study conducts offline learning conditions before the COVID-19 pandemic.

Unfortunately, due to the COVID-19 pandemic, online learning activities such as Plant Anatomy courses must be enforced. Plant anatomy is one of the courses equipped with practicum activities. Some studies show that practicum activities can improve cognitive abilities. It combines hands-on activities with students' thinking processes. Thus, it provides psychomotor skills, systematic thinking, objective, creative, quantitative literacy, science process skills, and the ability to use a microscope (Agustina et al., 2022; Muhibbuddin et al., 2018; Muspiroh, 2012; Nuraeni et al., 2015; Sugianto et al., 2020). Plant tissue is the subject of plant anatomy. Thus, the other study strives to produce a three-dimensional media of wood cross-section to help students learn (Pahlelawati et al., 2020). Another research uses a digital microscope in blended learning to measure multiple intelligence profiles. However, the result shows that the students' multiple intelligence is still low (Sugianto et al., 2020). Research related to creativity measurements in plant anatomy courses was done before the COVID-19 pandemic. However, the change in online learning in Universitas Islam Negeri (State Islamic University - UIN) Sunan Gunung Djati, Bandung, has resulted in student practicum activities. Higher education must follow the directions from the Ministry of Religion and the COVID-19 task force in Bandung, West Java. Meanwhile, the online practicum activities resulted that student did not understand the practical steps because they did not use a microscope and did not slice the sample. Students, instead, are directed to independently read and observe plant anatomy pictures from textbooks and various internet sites. This condition requires a learning strategy, in this case, practicum, which can foster students' independence and thinking skills (Putri et al., 2020). A learning approach that accommodates practicum activities to empower students' creativity during the pandemic is still needed.

The application of the STREAM approach can be one of the best options. Authentic assessment can be used in the STREAM approach, as is used in the STEM and STEAM approaches (Agustina et al., 2019; Anwari et al., 2015; Capraro et al., 2013; Hunter-Doniger & Sydow, 2016; Rustaman et al., 2018; Septiani & Rustaman, 2017; Yakob et al., 2021). Authentic assessment includes performance assessment of the product. Performance assessment can improve habits of mind which are very important in science learning (Yakob et al., 2021). Habits of mind include creativity (Agustina et al., 2020; Rustaman et al., 2018). Performance assessment can be used to measure creativity (Rustaman et al., 2018). Performance assessment can be completed with a performance task along with a scoring rubric (Agustina et al., 2019). The result of a previous study regarding the STREAM approach in Traditional Biotechnology courses showed the highest skill is on the elaboration indicator (emerging level). The emerging level means that student creativity has begun to emerge, but the quality is still limited. The lowest skill with a "not yet evident" level is on the originality indicator. The "not yet evident" level indicates that students' products are still not original or not creative (Agustina et al., 2019). Creativity that is still limited and not evident becomes a challenge for educators to provide creativity to students in other practicums. Ahmad et al. (2021) stated that educators should creative and build student creativity, in this case, students to learn independently.

In addition, research on performance assessment of plant anatomy structure model products such as root, stem, and leaf anatomical structures has not been widely carried out at the university level. Therefore, to continue to provide students with the 21st-century thinking skills, mastery of technology, build creativity, and preparation for global challenges despite the COVID-19 pandemic, a study was conducted on performance assessment for students in the plant anatomy practicum. The practicum is conducted online using the STREAM approach to identify the level of creativity. Performance assessment is measured on the students' practicum report. Students make a product of the plant anatomy structure model which is then reported in a practicum report. The purpose of this study was to identify the level of student creativity in various indicators of creativity through a performance assessment of the product of the practicum report.

METHOD

The Static-Group Comparison Design (Fraenkel et al., 2011) was used as a research design (Figure 1). The research samples consist of two classes, the intervention, and the regular class. The intervention class used the STREAM (X), while the regular class used conventional learning. Each group was observed (O) through a performance assessment of the practicum report on plant anatomy structure models. Each student works on a practicum report.

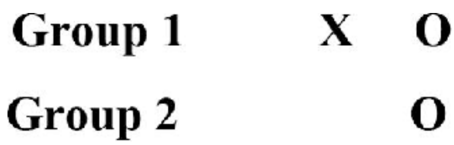


Figure 1. The static-group comparison design

The target population is the fourth-semester university students of the 2020/2021 academic year. The target population consists of three classes (IV-A, IV-B, and IV-C) with 116 students. The sample was chosen by the purposive sampling technique. Class IV-A is a regular class (Re) with 39 students. Class IV-C is an intervention class (In) with 38 students (Table 1).

Table 1. Class Distribution

Semester-Class	Treatment	Student
IV-A	Regular (Re)	39
IV-C	Intervention (In)	38

Students have to make one of the eight models of the anatomical structure of plants. The models include monocot roots, dicot roots, monocot stems, dicot stems, bifacial leaves, unifacial leaves, isobilateral leaves, and pinophyte leaves structure model. The random sample technique was carried out by drawing lots without returning the result to determine the plant anatomy structure model made by the student. Each student will make one of the plant anatomy models based on the lottery result. Performance tasks are given to students to guide the process of making a plant anatomy structure model. The performance task consisted of STREAM aspects combined with creativity indicators, namely aptitude characteristics in creative thinking skills. Table 2 shows an example of a performance task framework. Each student makes a practicum report to identify the level of creativity based on the performance task in drawing a plant anatomy structure model. The percentage of each creativity indicator is shown in Figure 2. The extensive composition of performance tasks is the fluency indicator.

Performance assessment of the practicum report product using an analytical rubric instrument and a score between zero to four (0-4). Data analysis techniques on each indicator of creativity (fluency, flexibility, elaboration, and originality) are made in the form of achievement in percentage (%). Furthermore, the level of creativity is determined. The categorization of creativity level is presented in Table 3 (Agustina et al., 2019; Rustaman et al., 2018). The study uses a field note format to support the descriptive discussion.

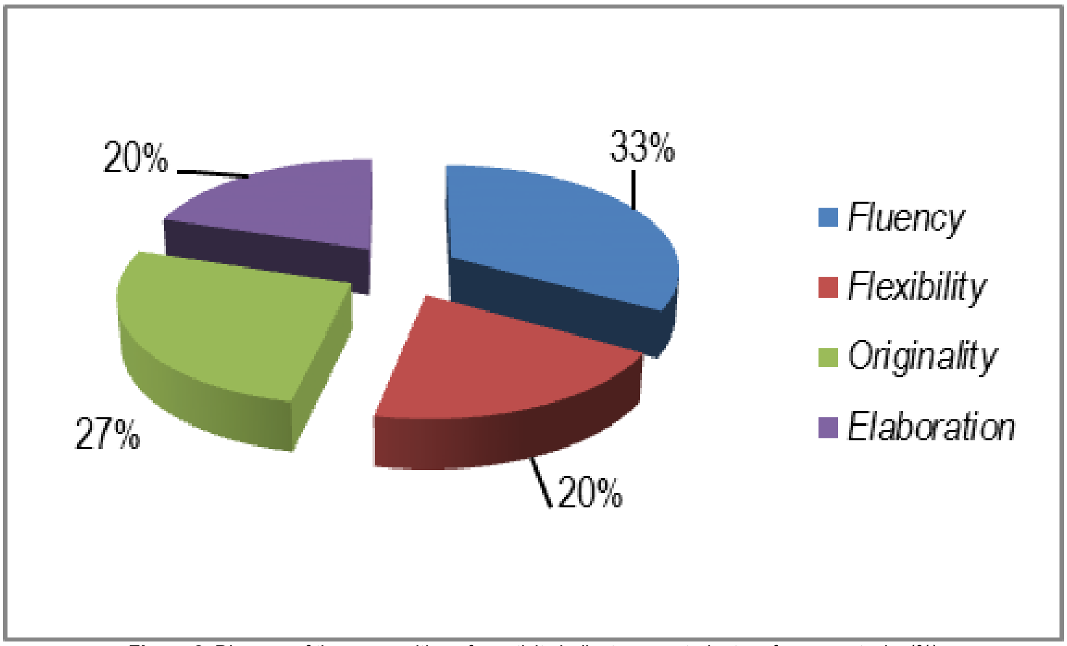


Figure 2. Diagram of the composition of creativity indicators on student performance tasks (%)

Table 2. Example of a student performance task that combines the STREAM approach and creativity indicators

Aspect	Description	Creativity Indicator	Description
Science	Problem Identification	Fluency	Expressing many ideas in solving problems in modelling the structure of plant anatomy
		Originality	Expressing ideas in solving problems that have never been thought of by others
Technology	Using tools available in their environment	Flexibility	Listing five tools and their uses
Religion	Two indicators: 1. Core competency 1 (spiritual) 2. WMI Paradigm	Fluency	Explaining fluently two indicators of religion aspect: core competency one (to be grateful for, care for, and use natural resources) & the WMI paradigm (for example, the creation of plants listed in the Qur'an)
Engineering	Plant anatomy workflow design and structural model	Originality	Creating a workflow design and a plant anatomy structure model design that is different from other people
		Elaboration	Making a minimum of eight or more steps of modelling the anatomical structure of plants in an orderly and detailed manner
Arts	Innovation	Flexibility	Creating plant anatomy model product with a beautiful appearance
Mathematics	Number of tools needed and number of materials	Elaboration	Determining (calculating) the number of tools and materials required in a detailed, realistic, and economical way

Table 3. Creativity level and its description

Achievement	Creativity level	Description
≤ 59%	Not yet evident	Creativity cannot be observed and is not original in the student data (not creative)
60%-75%	Emerging	Creativity has started to emerge with little evidence on the student data, the quality is still limited and inconsistent
76%-85%	Expressing	Creativity regularly appears, is expressed spontaneously, is of high quality, and can be observed in the student data
86%-100%	Excelling	Creativity emerges consistently with outstanding talent, depth, quality, and originality in the student data

The stages of implementing the STREAM Approach research are presented in Figure 3 and Figure 4. The flow of the plant anatomy practicum during the COVID-19 pandemic includes three stages: the preparation stage, the debriefing stage, and the STREAM approach stage (research stage). The preparation stage is compiling the performance tasks and rubrics, scoring product performance assessments, practicum reports, and field note formats. The debriefing stage is the first part of the practicum activity using the WhatsApp group application, Google Meet, and collecting tasks via Google Drive. Students identify, differentiate, and compare various components of plant tissue structures that compose roots, stems, leaves, and flowers. They may browse the resource from books or the internet. Students are assigned to draw the plant tissue structures, give colors, describe them briefly, and name the parts correctly.

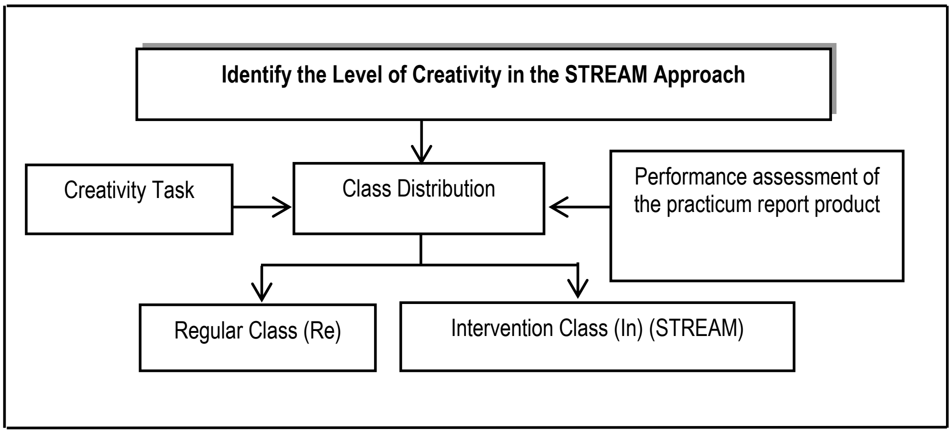


Figure 3. Detailed schematic of plant anatomy practicum part 2 (research)

The research stage is the practicum using the STREAM approach. The steps and framework of the STREAM approach in more detail are attached in the supplementary. The STREAM framework in the plant anatomy practicum is based on The Next Generation Science Standards (NGSS) and includes three dimensions: (1) scientific and engineering skills; (2) cross-cutting concepts in studying science and engineering; and (3) understanding of the core material in studying science (Anwari et al., 2015; Bybee, 2010).

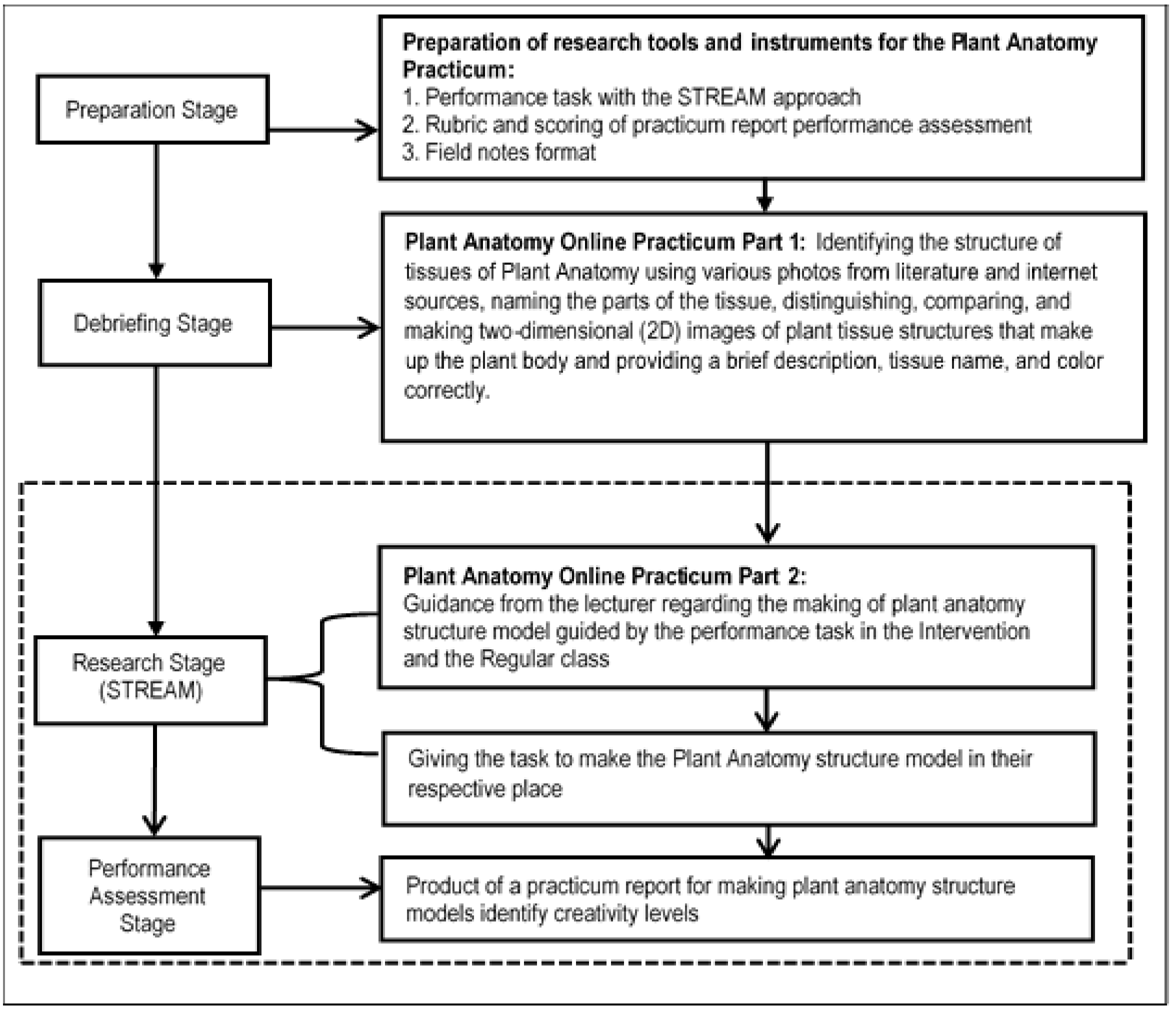


Figure 4. Flowchart of plant anatomy online practicum

The core material used is plant anatomy. Students exchange ideas to solve problems with a team of research lecturers and one senior student as a practicum assistant. Students compile a practicum report related to the plant anatomy structure model. The students' tasks (practicum reports) are collected using Google Drive. Each student makes a practicum report.

RESULTS AND DISCUSSION

The overall achievement of creativity in Figure 5 shows the highest achievement in the intervention (In) class, namely the excelling level. The excelling level means creativity emerges consistently with talent, depth of quality, and originality in student products. Meanwhile, the highest achievement in the regular class (Re) was at the emerging level. The emerging level shows that creativity has just started or has begun, as marked by the evidence in student products that are still few with limited and inconsistent quality. In a regular class, there is a 12.82% NYE (not yet evident) level. According to Rustaman et al. (2018) it means students are not creative or student creativity cannot be observed and is not original in student products.

The student creativity level that learns using the STREAM approach shows better results than the regular class. The STREAM approach can accommodate the creativity indicators, as presented in Table 2. Aspects of science related to the problem identification stage can empower fluency indicators. This stage facilitates students to empower their ability to express many ideas in solving problems regarding the structure model. This stage can also enhance the originality indicator. Students can express ideas by solving problems that have novelty. The technology aspect is related to the design of tools, materials, and work steps. This aspect can be relevant with a flexibility indicator in which students can categorize tools and materials appropriately. The categorization of tools and materials is at least five tools and four materials. The engineering aspect can prove the originality indicator that students can create workflow designs of plant anatomy structure models on their ideas. Additionally, the engineering aspect can also empower the elaboration indicator. It is because they can make a minimum of eight or more work steps in a sequence and in a detailed manner. The flexibility indicator means that students can elaborate on tools and materials.

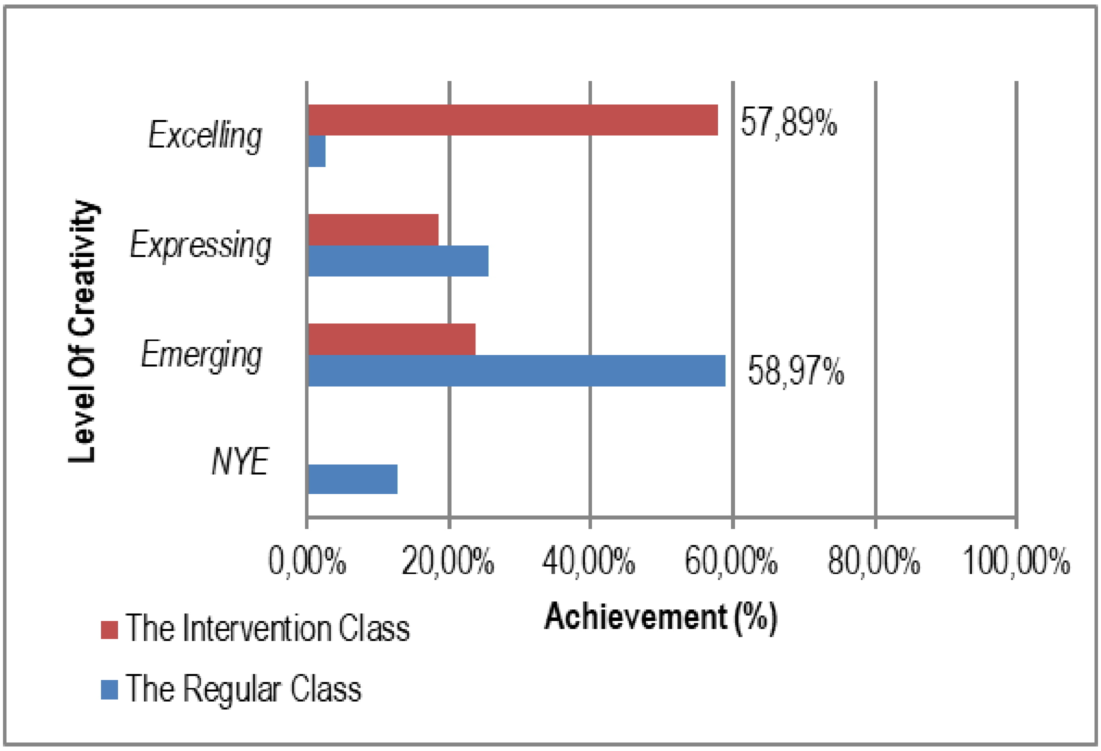


Figure 5. Overall creativity achievement

Furthermore, the math aspect is relevant with the elaboration indicator which students can determine the number of tools needed and the number of materials in detail, realistically, and precisely. The art aspect (innovation) parallels the flexibility indicator in which students can produce plant anatomy structure models with a beautiful appearance by utilizing found tools and materials in the environment. The religion aspect that is added to the STEAM to become STREAM is in line with piety and ahlaqul kharimah which also affect the creativity aspect. Several research results show that creativity must still be based on Islamic aqidah and sharia (Agustina et al., 2019; Al-Karasneh & Saleh, 2010; Daud et al., 2012). Religion is also related to creativity, especially in fluency indicators, as shown in the rubric and scoring of practicum reports (Agustina et al., 2019) in Table 4. Students fluently provide explanations about indicators of religious aspects in their practicum reports.

Table 4. Religion is combined with creativity indicators in the rubric and scoring of the practicum report

Religion Aspect	Indicators	Scoring Criteria				
	Creativity	0	1	2	3	4
Two indicators: a. Core competency 1 (spiritual) from the 2013 curriculum b. Revelation Guiding Science (Wahyu Memandu Ilmu – WMI) paradigm	Fluency: Fluently explaining the two indicators: Core competency 1 one (to be grateful for, care for, and use natural resources) & the WMI paradigm (for example, the creation of plants listed in the Qur'an)	Does not explain the two indicators	Explained only one of the two indicators, but the explanation is still incorrect	Explained the two indicators, but the explanations are still incorrect	Explained one indicator correctly, but get the other explanation incorrectly	Explaine d the two indicators correctly

The result related to the previous research on Traditional Biotechnology courses shows that the highest achievement of creativity level is at the emerging level in offline learning conditions before the COVID-19 pandemic (Agustina et al., 2019). Therefore, the STREAM approach to the plant anatomy practicum, even under an online practicum session, gives better results. It is because most students (57.89%) are at the excelling level in the online plant anatomy practicum. Learning in online conditions has advantages like flexibility and accessibility (Chandrasiri & Weerakoon, 2021; Cutri et al., 2020). It provides an opportunity for students to search for various information easily through internet sources related to the plant anatomy practicum. Putri et al. (2020) also prove that students can solve practical problems at home. Students can criticize, select information, and decide to solve problems based on the information they get. In addition, the student's independence can be enhanced (Ahmad et al., 2021). In the STREAM approach, students are more challenged and interested in making the best possible plant anatomy structure model. Students can criticize sources of information and decide what information is needed to solve problems. Students can analyze problems, then determine tools and materials to design and create a plant anatomy structure. Students can follow STREAM steps in aspects of science, technology, engineering, and mathematics combined with aspects of arts and religion so that they can empower creativity.

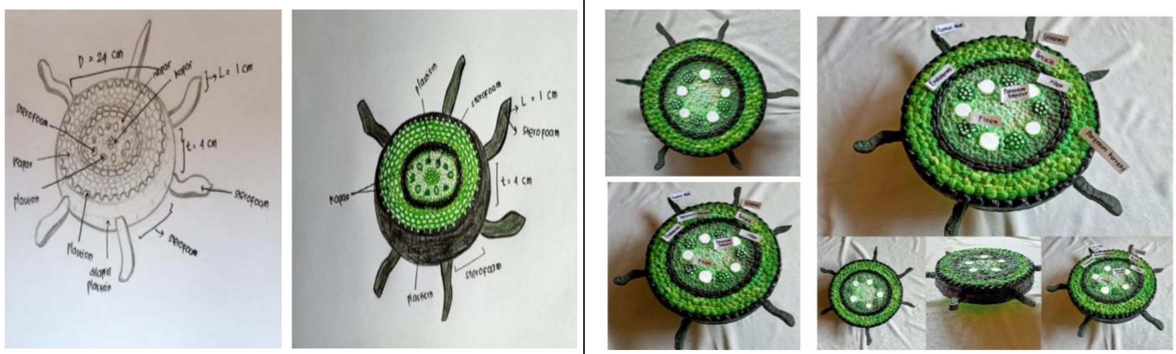
Table 5 shows the distribution of creativity levels for each indicator in the Regular (Re) class, from the NYE (not yet evident) to the excelling level. In the intervention (In) class, the creativity levels range from emerging to excelling on fluency and flexibility indicators. Meanwhile, the originality and elaboration indicators show 0% at the Not Yet Evident level. The highest level of creativity in the regular class is elaboration, while the intervention class is a flexibility indicator. The elaboration indicator means that students can develop or enrich other people's ideas (Agustina et al., 2019; Rustaman et al., 2018). Based on the scoring rubric of the performance assessment, the elaboration indicators are as follows: (1) Students can specify the number of tools and materials needed that show the mathematics (M) aspect; (2) Students can detail the eight steps in making a model sequentially and correctly that show the engineering (E) aspect; and (3) Students can specify the budget requirements for making the structure model that show the mathematics (M) aspect.

Table 5. Creativity level on each indicator

Creativity Indicator Level (%)	*Fluency*		*Flexibility*		*Originality*		*Elaboration*	
	Re	In	Re	In	Re	In	Re	In
Not yet evident (NYE)	41.00%	5.26%	28.20%	2.63%	79.48%	0.00%	7.69%	0.00%
Emerging	56.00%	42.10%	35.89%	18.42%	17.94%	26.31%	38.46%	39.47%
Expressing	4.50%	36.84%	12.82%	26.31%	2.56%	21.05%	25.64%	57.89%
Excelling	0.00%	15.78%	23.07%	52.63%	0.00%	52.63%	28.20%	2.63%

In the intervention class, the highest level is on the flexibility indicator which students can think flexibly in problem identification by thinking about different ways to solve problems (Agustina et al., 2019; Rustaman et al., 2018). Flexibility indicators in the rubric and scoring performance, are as follows: (1) Students can classify or categorize four to five tools and materials correctly that show the technology (T) aspect; (2) Students can explain aspects of religion based on core competency 1 (KI 1) and the WMI paradigm, and show the religion (R) aspect; and (3) Students can make an exquisite plant anatomy structure model by utilizing the tools and materials available in their environment that show the art (A) aspect.

Based on the field notes, students in online practicum conditions show flexibility in obtaining information about making practicum reports from various literary sources. The example in Figure 6 shows the model design aspect of monocot root anatomy on the engineering aspect (left, a) and the structure model on the art aspect (right, b) listed on the student practicum report.



(a) (b)

Figure 6. Example of anatomical structure of monocot root that design by student showing the engineering and art aspects

Based on the scoring rubric of the performance assessment, the engineering (E) aspect is relevant to originality. Students design the anatomical structure of monocot roots by their ideas based on literature study. Students also show the mathematics (M) aspect by determining the root diameter in the design of the root structure model. Students design the model using tools according to their thinking that can be different from the thoughts of others. The tools used in one of the sample student reports shown are one cutter, six small brushes, one glue gun, and one watercolor palette. Examples of materials include one piece of styrofoam adjusted to the diameter of the monocot root structure model, three packs of plasticine, one pack of cotton, two wax glue, three acrylic paints, two double tips, and one tissue pack. The art aspect of the product model of the anatomical structure of monocot roots is related to indicator flexibility. Students provide the names of the tissues that make up the anatomical structure model of monocot roots using tools and materials available in the environment.

The STEM, STEAM, and STREAM approaches can provide the students with creativity at the junior high school, high school, and university levels (Agustina et al., 2019; Annisa et al., 2018; Fatmah, 2021; Rohman et al., 2021; Rustaman et al., 2018). The approaches can even provide problem-solving skills (Anindya & Wusqo, 2020; Jacques et al., 2019; Perignat & Katz-Buonincontro, 2019). A recommendation related to a preliminary study by Azizah et al. (2019) is that the STREAM approach is a solution to improve the critical thinking skills of elementary school students. Creativity, problem-solving, and critical thinking skills include higher-order thinking skills (Binkley et al., 2014; Care & Kim, 2018; Liao et al., 2016; Zubaidah, 2019). Therefore, the STREAM approach can support higher-order thinking skills (21st-century skills). It is in line with the goals of higher education in particular. In addition, the 21st-century skills assessment of teacher candidate students is valuable for Islamic higher education institutions (Haviz et al., 2020). As well to the STEM and STEAM approaches, the STREAM approach can use authentic assessments, including performance assessments of student creativity. The authentic assessment is one of the standards in science learning.

CONCLUSION

The implementation of an online practicum in plant anatomy course during the COVID-19 pandemic consists of three stages: (1) the preparation stage, (2) the debriefing stage, and (3) the STREAM approach stage (research stage). The preparation stage includes the preparation of learning tools and research instruments. The second stage is the debriefing stage. The third stage with the STREAM approach is making a practicum report of designing a plant anatomical structure model. The third stage identifies the level of student creativity. The student's creativity in the intervention class gave better results than in the regular class. The results showed that the creativity level of the intervention class is excelling (57.89%), while the regular class the emerging (58.79%). Most of the students reached the excelling level in the intervention class. The flexibility indicator is found to be the strongest indicator. The STREAM approach provides a better level of creativity.

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