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Creativity Profile of Students in Constructing Mathematics Learning Media

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ABSTRACT

Students must be equipped with creativity as a 21st century skill. The research objective was to obtain a profile of student creativity in constructing learning media. The method used is observation and in-depth interviews. The researcher is the main instrument and observation guide and interview guide as a supporting instrument. The research subject was one of the students of the mathematics education study program taking the mathematics learning media course. The results of student creativity research, namely the subject of creating new ideas in constructing different mathematics teaching aids, using the basic concepts of multiplication and division of positive integer operations that are formed on boards and there is a touch of technology in the form of lights and barcodes. Subjects apply creative ideas as real contributions in the form of the KoKagi Ke Wort demonstration tool. The creative idea is evident in the use of lights and barcodes that can be copied using a smartphone, so that learning videos and material on prime numbers can be displayed through the LCD projector. Learning videos and practice questions for studying at home via can also be accessed via the link from the barcode.

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A. INTRODUCTION

The first set of 21st century skills focuses on critical learning skills and innovation, critical thinking and problem solving (expert thinking) communication and collaboration (complex communicating), creativity and innovation (applied imagination and invention) (Trilling & Fadel, 2009). This suggests that the first set of 21st century skills focuses on creativity. Creativity is needed by students when dealing with tasks that require constructing a mathematics learning aid that is different from pre-existing aids. The importance of creative thinking is a way to generate ideas that can be applied to world problems (Anwar et al., 2012).

Collaboration is needed by students when they have to complete group assignments. Thus, the four skills needed in the 21st century can be developed in students as future mathematics teachers. The four skills needed in the 21st century are a subset of soft skills. This is according to the results of research Hidayati (2013) that prospective mathematics teacher students must develop attributes of soft skills including verbal and nonverbal communication that can be used to convey abstract mathematical ideas. Creative mathematics learning media often involve collaborative activities and communication between students. For example, the use of games or group projects can encourage students to interact, discuss, and work together in solving

math problems. This helps develop students' social skills and communication skills (Vorderman, 2014).

Creativity is a skill that must be prepared for students in education in the 21st century. These skills are needed in learning media lectures, where students are directed to construct mathematics learning media that are easy for students to understand, so that the media is one of the determining factors for success in achieving learning goals. The use of mathematics learning media, especially teaching aids that have been constructed by students, can help students learn to understand abstract mathematical objects into concrete ones. The benefits of visual aids in learning mathematics are that they help visualize mathematical concepts more concretely, provide opportunities for students to 'hands-on learning' or engage in doing mathematics, and provide opportunities for students to experience learning mathematics in a fun way, and improve student learning motivation(Marshal, 2008).

By using creative elements such as pictures, animations, games, or stories, mathematics learning media can attract students' interest. This can motivate them to be actively involved in learning mathematics and speed up the understanding process (Boaler, 2015). Mathematics often involves abstract concepts that are difficult for some students to understand. With a creative approach, teachers can use analogies, visualizations, or graphical representations to describe these concepts more clearly. This helps students understand the material better (Briggs, 2007). The use of creative elements in mathematics learning media can help improve students' memory (Leinwarnd, 2014). For example, using mnemonics or jingles can help students remember math formulas or problem solving steps more easily.

Learning media is one of the compulsory subjects for students in the undergraduate mathematics education study program at Higher Education X. The description of the learning media course is that through a project-based learning model, students are able to compile proposals, miniatures, and mathematics learning aids for elementary or secondary school levels. Students will also learn to present proposals, miniatures, and teaching aids for learning mathematics produced in class. Students in the end implement mathematics learning aids that have received approval from the supporting lecturers at partner schools. Students are expected to be able to choose mathematics learning media for students because one of the factors that determine the success of learning mathematics is the learning media used (Widodo, 2018). Learning media can help students to make abstract mathematics abstract mathematics. Apart from the media, meaningful learning is learning that is adapted to the cognitive development of students.

Permendikbud number 3 of 2020 concerning National Higher Education Standards, article 14 paragraph 3 that learning methods that can be chosen for implementing learning in courses include: group discussions, simulations, case studies, collaborative learning, cooperative learning, project-based learning, problem-based learning, or other learning methods that can effectively facilitate the fulfillment of graduate learning outcomes. Therefore researchers apply project-based learning in groups. Project-based learning is a systematic teaching method involving students, in this case students, to learn skills knowledge through a structured process, with real experience and details designed to produce products (Sutirman, 2013). Through this study, researchers will get a profile of the creativity of prospective teacher students. Creative

thinking activities in this case are how students relate knowledge and learning theory in constructing learning media.

The fact is that creativity has not been comprehensively mastered by students. This is because the opportunities that students receive to explore creative skills are not yet optimal. Through the implementation of lectures that require students to construct ideas outlined in proposals, construct mathematics learning aids, present and implement the results of mathematics learning aids produced in groups, it is hoped that a comprehensive profile of student creativity skills can be revealed.

This student is a teacher candidate where a teacher must have creativity. A creative teacher is a teacher who has the ability to develop new ideas and new ways of educating, teaching, guiding, directing, training, assessing and evaluating students (Oktiani, 2017). Teacher's ability to make mathematics learning media, develop mathematics learning media in the medium category and requires intensive training (Prahmana et al., 2017). Therefore research is needed on creativity in constructing learning media. Much research has been done on the creativity of teacher or student teacher candidates including Umar & Ahmad, (2019) which describes the creative thinking abilities of student teacher candidates in solving math problems, Rezkia & Rivilla (2017) describes the creativity of math teachers in carrying out learning according to the characteristics of children, and Kurniawan (2017) describe the level of achievement of the objectives of using the project based learning (PjBL) model in increasing the creativity of prospective teacher students in making mathematics learning media based on Cirebon local culture, Setiono & Rami (2017) describe the creativity of teachers in using learning media. It appears that no previous research has described the creativity of prospective teacher students in constructing mathematics teaching aids. The novelty in this study is the exploration of students' creative skills which are carried out comprehensively in mathematics learning media courses. Exploration is more focused on the construction of mathematics teaching aids in accordance with the analysis of needs identified beforehand, constructed, and implemented in the learning process in partner schools. The resulting objective is in the form of a profile of student creativity in constructing mathematical teaching aids.

Istianah (2013) said that there are four stages in creative thinking, namely; (1) Exploring, identifying what you want to do; (2) Inting, looking at or reviewing various traditional tools, techniques and methods; (3) Choosing, identifying and selecting the most likely ideas to be implemented; (4) Implementing, how to make an idea implemented. Creative thinking according to Krulik & Rudnick (1999) includes synthesizing, building, and implementing ideas. Creative thinking in mathematics includes flexibility, fluency and novelty (Krutetskii, 1976; Pehkonen, 1992; Silver, 1997). Furthermore, Siswono (2016) develops the theory of creative thinking in the form of creative thinking stages. Creativity indicators in this study refer to the theory of Sunardi et al., (2017) including: (1) creating new ideas; (2) Expanding basic ideas/concepts to increase and maximize creative efforts; and (3) applying creative ideas as a real contribution to life. The research objective was to obtain a profile of student creativity in constructing learning media.

B. METHODS

This research is a qualitative research conducted at Higher Education X. The class used for this research is the class attended by class 2020 A students who are taking an instructional media course. The time for conducting research is in the odd semester of 2022/2023. Data collection methods include observation methods and in-depth interviews to obtain a profile of student creativity in constructing mathematics teaching aids in a comprehensive manner. The main research instrument is the researcher himself, while the supporting instruments include observation guidelines and interview guidelines which have been declared valid by expert validators. Observation guidelines were used to observe the subject's performance during the completion of the task of constructing the selected mathematics learning aids, presenting the results of the construction of mathematics learning aids that had been produced in front of the class and implementing the mathematics teaching aids produced in partner schools. The interview guide was used to explore and confirm the results of in-depth observations to obtain a comprehensive profile of student creativity. The two supporting instruments have been validated by an expert validator and declared feasible to be used to obtain a profile of the creativity of students who are taking instructional media courses.

Prospective subjects in this study were students who were taking mathematics learning media courses which were grouped into 6 groups. Each group consists of 3 students. The subjects selected were equal groups, meaning that groups were selected with the same mathematics learning aids for elementary school students, so that there was 1 research subject, namely group members who had the first idea and received approval from the course lecturer. The subject was selected by one student from a group that constructs teaching aids for learning mathematics for elementary students, while other students were not selected as subjects because the teaching aids were not made for elementary students.

The research was carried out during the 1 semester lecture period starting from identifying the need for teaching aids, construction of ideas in the form of proposals, construction of mathematics learning aids, presentation of the results of the construction of mathematics teaching aids and implementation in partner schools. The validity of the data used in this study with time triangulation. Time triangulation is carried out by observing and interviewing at least 2 (two) times at different times and situations until credible data is obtained to be analyzed in depth.

C. RESULT AND DISCUSSION

This research was conducted in an odd semester of the 2022/2023 academic year. From September to December 2022 to be precise. The following are the results of the construction of the mathematics learning aids produced by the research subjects. The subject produced a teaching tool for learning mathematics which was named the KoKagi Ke Wort "*Konsep Kali Bagi Bersama Kelinci & Wortel".*

1. Create a new idea

Before the subject constructs the mathematics learning aids, the subject observes the learning situation carried out by the teacher at MI Al-Mujahidin Parimono Class 2 Ar-Rosyid, interviews the mathematics teacher, analyzes the material and teaching aids that already exist. This shows that the subject constructs props by considering objectivity factors not based on

personal pleasure (Djamarah, 2005). The results of observations and interviews of learning situations conducted by the teacher show that the teacher teaches using the lecture method, without the help of learning media / teaching aids, there are children who fall asleep in class when the lesson takes place, with the excuse that they are not enthusiastic about learning mathematics, and there are children who play alone, chat with his friends when the teacher explains the material in front. interview results show that: the teacher has taught at this school for about 5 years, the teacher graduated from the English language education study program but teaches mathematics, so far the teacher has used the lecture method and explained using only the blackboard, the teacher realized that the method used was not effective because the children were sometimes busy talking with friends to play, children sometimes get bored, some sleep in class. Sometimes the teacher uses several yells during the teaching and learning process, but the teacher never uses any learning media because the costs of making media are not cheap, operating media is not easy, requires a lot of time in teaching, it is difficult to find media that is appropriate to the material mathematics.

The results of the subject in analyzing students' abilities to understand multiplication of integers were students working on questions for a long time, there were students who still had difficulty in counting, so students used the help of their feet to count, there were also those who borrowed the hands of friends. The result of one student's answer which is the basis of the subject in analyzing the ability to understand multiplication material is shown in Figure 1.

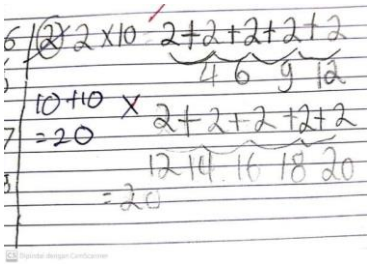

Figure 1. Results of Student Answers

The subject determines the various types of learning media. The subject conveyed the existing props about multiplication and division of integers, namely the multiplication board and Bekapai. Subjects as prospective teachers meet creative criteria according to Setiono & Rami (2017). It is said to be creative when the teacher explains and uses various types of learning media. Subjects obtain learning media from various sources, namely YouTube. The subject describes each learning media about multiplication and division. The results of the subject in analyzing the props that have been used are shown in Figure 2.

Differentiator	Learning aids 1	Learning aids 2
Learning aids		
the name of the learning aids	multiplication board	Bekapai "Belajar Konsep Asli pembagian Matemati" with the theme of honey bears and bekapai gardens
material used	multiplication	division and the remainder theorem
maker name	Bayin Fuadah	Kezia dan Miranda
year, city	2020, Tegal	2018, Balikpapan
source	YouTube	YouTube

Figure 2. Subject results in the Multiplication Teaching Tool Analysis

The subject makes his own learning media that is different from the previous media. Based on the results of observations of learning situations, interviews with mathematics teachers, analysis of existing materials and teaching aids, the subject constructed the KoKagi Ke Wort teaching aids. This teaching aid consists of question cards, answer cards, times or division indicator cards, spinner wells which are used as indicators for multiplication or division questions, carrots and pots as concrete objects to solve problems, and true or false indicator lights. If the student answers correctly then the green light will turn on, but if the student's answer is wrong then the red light will light up. The subject's creativity in developing learning media in the form of the KoKaGi Ke Wort teaching aid is the ability to modify learning media into new and useful forms (Syaikhudin, 2013). The subject made KoKagi Ke Wort props based on modifications of existing learning media by equalizing the procedures for using props based on the concepts of multiplication and division and shown in Figure 3.

Figure 3. Subject Results in Constructing the KoKagi Ke Wort props

The subject explained how to use the KoKagi Ke Worte props in the multiplication concept, namely:

a. Students press the switch on the dynamo spinning well as a multiplication problem determination.
b. After getting the multiplication indicator, the multiplication or distribution card is placed in the pocket provided.
c. Students are given the opportunity to pick 2 numbers at random on the number cards provided.
d. Then the number cards that are obtained are placed in arrow-shaped pockets.
e. Students take carrots according to the question cards obtained.
f. Then students calculate by planting carrots in the pots provided.
g. After getting the answer, the student takes the result card and places it in the bag provided.
h. If the answer is correct, the green light will turn on, and if the answer is wrong, the red light will light up.
i. From working on these questions with the help of KoKaGi Ke Wort learning media, students can understand the concept of a multiplication.

2. Expand basic ideas/concepts to enhance and maximize creative endeavors

The subject creates new ideas in constructing different mathematics teaching aids, using the basic concepts of multiplication and division of positive integers which are formed on the board and there is a touch of technology in the form of lights and barcodes. Subjects apply creative ideas as real contributions in the form of prime number square boards that can be played by teachers and students in direct learning. Students can also play on their own using the manual that has been made by the subject. The creative idea is evident in the use of lights and barcodes. The lamp functions as an indicator light that the student's answer is correct when playing the props. Likewise the use of barcodes as shown in Figure 3, barcodes can be copied using a smartphone, so that learning videos and multiplication and division of positive integers can be displayed through the LCD projector. Learning videos and practice questions for studying at home via can also be accessed via a link from the barcode that has been sent by the teacher to the class grub, this is done so that students can study independently.

The subject comprehensively intends to assist students and teachers in solving problems encountered in learning multiplication and division of positive integers. The creativity of this subject is in line with the results of research (Isnaniah, 2017) which states that increased student creativity can be developed with a project-based learning model in mathematics learning media courses. Apart from that, this is also in line with the results of Nurhayati & Rahardi (2021) which shows that students' creative thinking skills in developing learning media are included in the modificative creative model, namely changing the shape of a product so that it becomes more attractive and more practical; and developing mathematics learning media based on the problems found, in order to assist students in understanding learning material.

3. Apply creative ideas as real contributions in life

The subject applied the KoKagi Ke Wort teaching aid "Konsep Kali Bagi Bersama Kelinci & Wortel" in learning mathematics on multiplication and division of integers at MI Al-Mujahidin Parimono Class 2 Ar-Rosyid. Through the application of learning media, the subject creates student activity by forming groups. Each group consists of 3-4 students. The subjects gave the KoKagi Ke Wort tool to each group, so that each group could learn multiplication and division together as shown in Figure 4.

Figure 4. Subjects and Student Groups Study Multiplication and Division Materials through the KoKagi Ke Wort Trainer Tool

The subject communicates mathematical ideas in this case related to prime numbers by repeating the meaning of prime numbers several times, giving examples by giving a stronger intonation than when pronouncing other mathematical objects. This is in line with the results of research which states that mathematics teachers in delivering material use different intonations when conveying the preferred mathematical object (Hidayati et al., 2021). In addition, the subject also plays learning videos that have been made using barcodes as a means of learning for students at home independently. Nonverbal communication that appears is the material presented also in the form of writing and pictures presented using power point. Power point is presented very attractively to students, because it is made with several animations and a variety of letters that vary. This is in line with research conducted by Wahyuningsih (2017) media power point can increase the attractiveness, fun, active, curiosity of students to learn mathematics.

Before learning begins, the subject gives a math ability test in the form of a description problem with a total of 10 questions with the aim of knowing students' understanding of the material that has been studied, namely multiplication and division. The subject said that there were 29 students, the total score was 2,350, the average value was 81.03, the number of students who had completed their studies was 19, the percentage of learning completeness was 65.5%, the number of students who had not yet completed their studies was 10, the percentage had not been completed learning 34.5%. After the subject carried out the learning using the help of KoKaGi Ke Wort media, the subject gave post-test questions. The subject said that the total score was 2,505, the average value was 89.46, the number of students who had completed their studies was 22 students, the percentage of learning completeness was 78.57%, the

number of students who had not completed their studies was 6 students, the percentage had not completed their studies was 21.43%. This shows that the subject constructs teaching aids considering the effectiveness and efficiency of use (Djamarah, 2005). The effectiveness of teaching aids includes the use of these teaching aids. Teaching information (multiplication and division concepts) can be absorbed optimally by students. While efficiency includes the use of these props that require time, effort, and costs as little as possible to achieve the goal.

The subject gave praise to students who dared to play props and managed to answer correctly. This is a verbal non-mathematical communication that can be used to give students a sense of pride. This is in line with the results of research which explains that prospective teacher students during teaching practice also give verbal praise to students in the form of good, good, and smart words (Hidayati, 2016). The subjects contributed to the construction of the KoKaGi Ke Wort mathematics learning aids in a responsible way starting from analyzing the material, observing partner schools, compiling miniature teaching aids to implementation in partner schools. This is in line with the theory in project-based learning (Abidin, 2007; Winastwan & Sunarto., 2010) which states that project-based learning is enabling collaboration among group members, responsibility. Based on the results of this study, it was obtained a description of the indicators of creativity in constructing learning aids as shown in Table 1.

Table 1. Description of indicators of creativity in constructing teaching aids

Creativity Indicator	Description
create new ideas	1. Determine the various types of learning media. 2. Obtain learning media from various sources 3. Describe each learning media 4. Make your own learning media that is different from the previous media
Expand basic ideas/concepts to enhance and maximize creative endeavors	1. Provide additional new ideas in the media 2. There is an element of technology in learning media
apply creative ideas as a real contribution in life	1. Applying learning media in the learning process 2. Through the application of learning media, student activity is created 3. Improving student learning outcomes

Prospective teachers must have the ability to construct learning media. In accordance with the research conclusions of Hidayat et al. (2022), Purwandari et al. (2020), Tristanti et al (2021), Tristanti (2021); Tristanti & Iffah (2022) that the development of learning media is needed to instill the concept of mathematics and the effectiveness of learning mathematics and the meaning of learning mathematics for students. The ability of these prospective teachers will develop in learning media lectures where students are required to produce learning media products that support mathematics learning activities and practice by using and utilizing them in class (Kurniawan, 2017).

D. CONCLUSION AND SUGGESTIONS

Based on data analysis and discussion, it can be concluded that student creativity in learning mathematics media, namely the subject creates new ideas in constructing different mathematics learning aids, using the basic concepts of multiplication and division of positive

integer operations formed on the board and there is a touch of technology in the form of lights and barcodes. Subjects apply creative ideas as real contributions in the form of the KoKagi Ke Wort demonstration tool. The creative idea is evident in the use of lights and barcodes that can be copied using a smartphone, so that learning videos and material on prime numbers can be displayed through the LCD projector. Learning videos and practice questions for studying at home via can also be accessed via the link from the barcode. Suggestions that can be given are (1) lecturers in mathematics learning media courses should use learning models that can explore the creativity of students, so that the skills needed in the 21st century can be developed in students from an early age; and (2) further researchers are advised to dig up the information that is needed in the 21st century. in-depth knowledge of 21st century skills and other aspects that may be combined or developed in further research.

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