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Honey and Mumford learning style: creative thinking process in solving statistical problems

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ABSTRACT

This research revealed the nature of students' creative thinking processes with theoretical and pragmatic learning styles in solving problems. The creative thinking process of these students goes through the stages of synthesizing ideas, building ideas, planning the implementation of ideas, and implementing ideas. This research was conducted at one of the junior high schools in Pasuruan Regency, Indonesia. Prospective research subjects are second grade students, totaling 150 students. The research instrument is the researcher as the main instrument and is assisted by additional instruments, namely the learning styles questionnaire (LSQ), the creative thinking test presented in E-module using science, technology, engineering and mathematics (STEM) project-based learning, and interview guidelines. Based on the results of research on creative thinking processes in solving problems in students with theoretical learning styles and students with pragmatic learning styles, it can be concluded that there are differences in the creative thinking process at each stage, namely the stages of synthesizing ideas, building ideas, planning implementation of ideas, and implementing ideas. This difference is caused by differences in character between students with theoretical learning styles and pragmatic learning styles that influence students in building ideas to implement ideas.

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1. INTRODUCTION

Creative thinking is one of the cognitive skills that must be possessed by students to face future challenges. Creative thinking is a manifestation of higher-order thinking because creative thinking is a mental process that involves intuitive thinking and imagination thinking to produce new, unique and innovative ideas, ideas or products [1]. Creative thinking is usually associated with cognitive skills and abilities to produce new solutions in dealing with problems [2].

If it is linked between creative thinking and the creative thinking process, the creative thinking process is a sequence of thoughts and actions, which are characterized by the presence of steps in thinking activities, which ultimately can produce new ideas or works that can be expressed visually, verbally, acoustically, or visually mathematical [3]. A new idea or work is very important in the creative thinking process because novelty is one of the components in the definition of creativity. Creativity is a product of creative thinking [4]. When associated with mathematics, the thinking process is a process that produces unusual solutions and provides broad insight into the given problem. This unusual solution is defined as a

genuine, unexpected and original solution [5]. And usually, a person's creative thinking process is influenced by interactions with his environment and depends on the social and cultural level and social environment [6].

Research related to creative thinking processes has been researched by previous researchers [7]–[10]. If previous research tends to use the Wallas stage to determine the stages of the creative thinking process, this study uses the stages of the creative thinking process [5]. This is because at this stage the characteristics of each stage of students' creative thinking when learning in class are limited by learning time at school. The stage of creative thinking that is meant is a cognitive activity to build an idea or ideas that are new, flexible, and fluent. The idea or idea in question is an idea or idea in solving mathematical problems [11].

Problems in mathematics are usually in the form of math problems. These questions can be in the form of story questions, picture illustrations, or puzzles. The question will be a problem depending on the knowledge possessed by the answerer. When the problem cannot be solved, a problem will arise, namely a cognitive problem. Problems in mathematics are when someone is faced with a mathematical problem but cannot immediately find a solution. Every problem certainly requires a solution through the stages of problem-solving. Problem-solving can be interpreted as a process that asks someone to solve a new problem [12]. Research subjects were asked to solve problems related to statistical material presented in the form of an e-module. When solving this problem, the teacher applies a learning model based on science, technology, engineering and mathematics (STEM) project-based learning.

STEM learning project-based learning is learning that helps students to solve problems related to science, technology, and mathematics that are done in the form of projects [13], [14]. The application of STEM project-based learning can improve students' creative thinking [15]. STEM project-based learning is a learning model used to meet educational needs in the face of technological advances. This STEM project-based learning consists of five stages, namely: i) the preparatory stage, which is the stage that invites students to understand the problem; ii) the implementation stage is the stage where students create projects according to their ideas; iii) the presentation stage, which is the stage that provides opportunities for students to present the results of their project; iv) the evaluation stage is the stage used to evaluate the results of student projects; and v) the correction stage is the stage that asks students to make revisions according to the evaluation results that have been carried out [16]. STEM project-based learning can be applied to improve students' creative thinking [17].

Problem-solving requires the ability to think creatively to solve it. The use of creative thinking to solve problems can be adapted to learning styles so that it can improve the quality of learning so that learning objectives can be achieved [18], [19]. Many researchers agree that learning styles play an important role in education. Learning style is a person's style in absorbing information and processing information [18]. Experts have reviewed the theory of learning styles. However, in this study, the learning style that will be used is the learning style according to the ideas of Honey and Mumford [20]. This is because this learning style can be applied at all levels of education, even in tertiary institutions. This theory already has a tool to determine student learning styles using the learning styles questionnaire (LSQ). The theory of learning styles according to Honey and Mumford divides learning styles into four types, namely activist, reflector, theorist, and pragmatist. In contrast to previous studies, in this study, the profile of the creative thinking process in proposing and solving problems based on Honey and Mumford's learning styles, particularly theoretical and pragmatist learning styles, will be studied. This is because the character tendencies possessed by these two learning styles are very opposite. Someone with a pragmatist learning style prefers to come up with new ideas and prepare everything, then put it into practice, while someone with a theorist learning style prefers to understand theory first, before doing practice [21], [22]. There are differences in character between the pragmatist and theorist learning styles, which is the background for researchers to choose pragmatist and theorist learning styles in proposing and solving problems related to statistical material.

2. RESEARCH METHOD

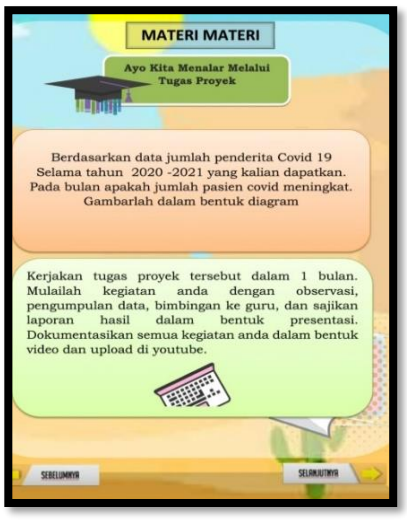
Research design is qualitative research that will reveal the creative thinking process of students with theoretical and pragmatic learning styles in posing and solving problems. This research was conducted at one of the junior high schools in Pasuruan Regency, Indonesia. Prospective research subjects are second grade students, totaling 150 students. The research instrument is the researcher as the main instrument and is assisted by additional instruments (LSQ), creative thinking tests, and interview guidelines. The LSQ will be distributed to prospective research subjects to determine their learning styles. LSQ has been tested for validity, which is presented in Table 1.

Based on Table 1, it can be concluded that the LSQ instrument used to measure learning styles. Subjects who have specified criteria will be selected as research subjects. The criteria are: i) students with an activist or theorist learning style; ii) ages ranging from 12-15 years; iii) having the same gender; and iv) having relatively the same mathematical abilities, especially in basic mathematics and has a grade point average (GPA) with a range of 8.50.

Table 1. Confidence intervals the LSQ

Respondent sample	Confidence intervals		
	Standard deviation	T statistic	P value
Respondent 1	0.243	1.913	0.056
Respondent 5	0.250	0.212	0.833
Respondent 11	0.235	2.455	0.014
Respondent 15	0.188	0.522	0.649
Respondent 22	0.237	0.785	0.833
Respondent 28	0.272	1.050	0.014
Respondent 30	0.149	1.349	0.602
Respondent 35	0.235	1.913	0.433
Respondent 41	0.224	1.654	0.294
Respondent 46	0.208	2.444	0.178
Respondent 49	0.232	2.432	0.142
Respondent 58	0.230	1.785	0.099
Respondent 63	0.271	1.859	0.015
Respondent 69	0.261	1.039	0.015
Respondent 71	0.247	0.029	0.075
Respondent 84	0.300	0.455	0.064

After getting research subjects that match the criteria, test questions will be given to determine the creative thinking process. The test questions are presented in the form of an e-module which is applied in STEM project-based learning. E-module based on STEM project-based learning is an e-module specifically for second grade junior high school statistics material with the subject matter of data measurement and data presentation. E-modules are more effective than using modules developed to prohibit theoretical concepts and assist students in visualizing, constructing, associating, and also thinking processes [17]. E-modules help students build concepts independently. The use of this e-module is based on STEM project-based learning which will provide opportunities for students to develop their creative thinking skills [23]. The data measurement material will discuss: i) data concentration measures, which will discuss understanding, project-based learning STEM-based modules, and mode [24], [25]; and ii) measures of data spread, which will discuss range, quartiles, interquartile ranges, and quartile deviations. While the material for presenting data will discuss the presentation of data in the form of diagrams consisting of bar charts, line charts, and circle charts and tables. Figure 1 shows e-module being given to students.



Based on the data on patients with Corona Virus disease (COVID-19) during 2020 - 2021 that you got, in what month did the number of COVID patients increase? Draw in the form of a diagram

Figure 1. E–module based on STEM project based learning

For the research to run well, in conducting interviews, the interviewer must act as a neutral party. This interview was conducted to dig deeper into the creative thinking process of the research subject. To make it easier to know students' creative thinking processes, an indicator of the stages of the creative thinking process is arranged. Table 2 describes the indicators of creative thinking process stages in problem-solving activities. Indicators of creative thinking process stages in problem-solving activities is a research development [26].

Table 2. Indicators of creative thinking process stages in problem-solving activities

No	Creative thinking process stage	Indicator
1.	Synthesizing ideas	Gather information that will be used to solve problems based on the problems posed by: a. Relate the concept or information used to solve the problem posed. b. Tried several possible ways to solve the problem.
2.	Building ideas	New ideas or ideas emerge to solve problems by: a. Write down ideas or solutions to the problems posed. b. Trying to find other solutions or ideas to solve the problem.
3.	Planning the implementation of ideas	Write down concepts related to the questions or problems posed.
4.	Implementing ideas	Using concepts in solving problems or problems posed.

3. RESULTS AND DISCUSSION

Based on the results of the LSQ analysis, it can be seen that the learning style of each research subject. The results of this analysis are used to determine the research subject. Table 3 presents the results of the analysis of student learning styles.

Table 3. Results of dissemination of learning style questionnaire (LSQ)

	Learning style Honey and Mumford						
	Activist	Pragmatist	Theorist	Reflector	Reflector and theorist	Pragmatist and theories	Pragmatist and reflector
Total	4	28	36	65	7	6	4

Table 1 shows that students have a tendency to have a reflector learning style (65 students) and students who have an active learning style are four students. However, because this research is focused on pragmatist and theorist learning styles, students with pragmatic and theorist learning styles will be selected as research subjects. In addition, additional criteria that research subjects must possess are: i) ages ranging from 12-15 years; ii) having the same gender; and iii) having relatively the same mathematical abilities, especially in basic mathematics and has a GPA with a range of 8.50. After selecting the subjects according to the criteria, the research subjects were obtained as shown in Table 4.

Table 4. List of research subjects

Research subject	Age	Gender	GPA	Graduate from the school mathematics development study course	Learning style
S1	14	Female	8.50	Graduate	Theorist
S2	14	Female	8.50	Graduate	Pragmatist

Based on the results of the analysis of the distribution of the learning style questionnaire, it was found that only active learning style subjects met the expected criteria. After that, the subject was asked to take a test to find out the creative thinking process in solving problems. The following are the results of the analysis of the creative thinking process in solving problems for the two subjects.

3.1. Character subject 1 (S1)

Based on the researcher's observations during lectures, subject 1 is famous for individuals who are very careful in acting so that they seem to lack self-confidence. Subject 2 tends to think step by step, this can be seen when doing assignments or group discussions. The advantage of subject 1 is to have logical thinking when compared to classmates, this is also seen when learning in class. When conducting group discussions or when answering a question or problem, subject 1 always answered systematically. Subject 1 tends to want to do the job perfectly, and feels uneasy if the task or work is not perfect. Subject 1 tends to be careful in making decisions. Before making a decision, subject 1 tends to analyze first and examine theory by reading books. Based on observations while working on the questions given, subject 1 worked very carefully, so he seemed less confident in his answers, but subject 1 can work systematically and in detail. Subject 1 tends to get ideas to solve problems based on literature review or knowledge gained during class learning. The following is the S1 creative thinking process in solving problems as presented in Table 5.

3.2. Character subject 2 (S2)

Based on the researcher's observations of subject 2 while attending lectures, it is known that subject 2 is a cheerful person, full of enthusiasm, and has practical thoughts, does not like things that trouble him. This can be seen when learning in class and when discussing with the group. When discussing with his group, subject 2 tends to give new ideas when compared to his friends. The new idea is immediately put into practice and confidently presented in front of his friends or lecturers. Although his new ideas are not always

accepted by his friends, subject 4 will not be offended and remain confident. Subject 2 tends to have an open mind, and likes to experiment (trial and error).

Meanwhile, based on the researcher's observations of subject 2 while solving the given questions, it is known that subject 2 gets ideas in solving problems based on observations around the class. To illustrate his idea, subject 2 conducted a simple experiment by drawing according to his idea. Table 6 shows the answer to subject 2.

Table 5. Creative thinking process analysis subject 1 in solving problems

No	Creative thinking stage	Theorist learning style subject data (S1)
1.	Synthesizing ideas	a. Determine the concept needed to solve the problem. b. ideas in solving problems based on data obtained about COVID-19 patients. The data was obtained from a hospital in Malang. c. The source of ideas is based on the learning experience when taking learning in math class.
2.	Building ideas	Analyzing data obtained from hospitals about COVID-19 patients
3.	Planning the implementation of the idea	a. Determine the steps for solving the problem. b. Less able to develop ways to solve the various problems and only use one solution method.
4.	Implementing ideas	a. Complete all orders in the question. b. Implement the idea to solve the problem.

Table 6. Creative thinking process analysis subject 2 in solving problems

No	Creative thinking stage	Pragmatist learning style subject data (S2)
1.	Synthesizing ideas	a. Determine the concepts needed to solve the problems. b. The idea comes from the learning experience when attending lectures in class.
2.	Building ideas	Analyzing data obtained from hospitals about covid-19 patients
3.	Planning the implementation of ideas	a. Determine the steps for solving the problem. b. Less productive in solving problems posed by only one way of solving.
4.	Implementing ideas	a. Implement the idea in solving the problem posed. b. Solve problems with the correct solution steps, difficulty in drawing a bar chart.

Learning styles will affect individuals in absorbing and processing information. Absorbing and processing this information, of course, is influenced by several factors, one of which is the environment. Learning style is a combination of the characteristics of cognitive, affective and psychological factors so that they can interact and respond to the learning environment [27]. A person can influence and be influenced by the environment in which he is located so that changes in individuals and the environment can support or hinder creative efforts.

Each individual certainly has a different learning style. This difference is caused by: i) differences in how individuals perceive and gain knowledge (perceive and gain knowledge); ii) individual differences in the formation of ideas and thought processes; and iii) individual differences in acting (act) as a result of learning. This difference in learning styles will affect the thinking process, especially the creative thinking process.

Several researchers have investigated the relationship between creative thinking processes and learning styles [18], [19]. The difference between this study and previous research lies in the difference in the research objectives. The purpose of this study is to describe the creative thinking process of students with theorist and pragmatic learning styles in proposing and solving geometric problems.

Based on the results of the study, it was found that the creative thinking process of subject 1 with the theoretical learning style in proposing and solving problems. At the stage of synthesizing ideas in solving problems, the subject (S1) works on the problem according to the idea of the previous problem, this shows that S1 is a consistent and systematic person [28]. Next, the S1 chooses the concepts needed to solve the problems. The source of ideas is based on the learning experience when taking learning in math class.

At the stage of building ideas in posing problems, the S1 writes about the idea of the problem design that will be submitted based on the previous idea. Next, the S1 is sketched that illustrates his idea. At this stage, the S1 can meet the aspects of novelty, fluency, and flexibility. Subject (S1) can meet the novelty aspect because it can solve problems that are different from problems that were solved previously. This is following the results of interviews with the subject (S1) which states that the problem posed is the result of thoughts, literature studies, and observations that are adapted to the daily experiences of the subject (S1), so that it is different from the questions asked previously. This is following the opinion of previous study [29], which states that novelty in solving problems is focused on the ability of students to solve problems that are different from the problems previously proposed. This is supported by Leikin and Lev [30] who state that creative abilities are unique and have different ideas compared to students in the same group.

Subjects (S1) can meet the fluency aspect because they can solve problems that are diverse and different from other students. In addition, the S1 can use the concept of collecting statistical data (adapted to

the daily experience of S1) to solve problems but it is different from common problems known to other students (in the same class). S1 was able to fulfill the flexibility aspect because he used a different solution as usual. flexibility in problem solving is focused on different solutions and the flexibility of different types of solutions. At the stage of building ideas in solving problems, the S1 has not met the flexibility aspect because it has not been able to provide various answers to the problems posed, even though the answers are correct. S1 can only solve problems with one solution. S1 meets the aspects of novelty and fluency.

At the planning stage of implementing ideas in problem-solving, the S1 determines the steps for solving the problem. The S1 looks very careful in solving the problems posed. This can be seen when S1 repeatedly checks the answers and does not seem to believe the answers. At the problem-solving stage, S1 completed all the instructions on the questions posed, S1 felt that there were no difficulties in solving the questions.

The creative thinking process of subject 2 with pragmatic learning style in solving problems, the results showed S1 completed all the instructions on the problem, and S1 felt that there was no difficulty in solving the problem. At the stage of building ideas when solving problems, the S2 has not met the flexibility aspect because it can only solve problems in one way of solving. However, the S2 meets the aspects of novelty and fluency because these questions are a matter of development based on the experience of the S2 in everyday life. At the stage of planning ideas when solving problems, the S2 writes down the steps for solving the problem posed and solves the problem posed by writing down the things that are asked and known in the problem. At the problem-solving stage, the S2 drew a bar chart according to the data obtained to solve the problem posed. Next, the S2 wrote the solution to the problem on the answer paper.

4. CONCLUSION

Based on the results of research on creative thinking processes in solving student problems with a theoretical learning style and students with a pragmatic learning style, it can be concluded that there are differences at each stage. These differences can be seen in the stages of synthesizing ideas, building ideas, planning idea implementation, and idea implementation. This difference is due to differences in character between students with a theoretical learning style and a pragmatic learning style. These character differences affect students in building ideas to implementing ideas.

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