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Research-based learning to increase creative thinking skill in mathematical Statistic

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Abstract. The purpose of this study was to determine the improvement of students' creative thinking skills by using research-based learning. The research method used was an experiment with the design of the One-Group Pretest-Posttest Design. The subjects used in this study were 30 students taken by purposive sampling. The instrument used is a test to measure the ability to think creatively. Data analysis techniques used are one sample t-test and N-Gain. The results of the study show that research-based learning can improve students' creative thinking skills in taking mathematical statistics.

1. Introduction

Creative thinking is something that is very important in modern life today so that this ability becomes something that must be owned by every individual as well as students in the 21st century in addition to problem-solving skills [1–4]. 21st-century life focuses on career skills and the ability of individuals to work effectively with diverse teams, be open-minded for a variety of ideas and values, set and achieve goals, manage projects effectively, take responsibility for results, demonstrate ethical practices, and greater accountability for themselves and society [5]. Thus students as one of the agents must have creative ideas to be able to compete in the era of information and communication [6].

Creative thinking is one of the abilities that must be achieved in learning Mathematics, but my love for this ability rarely gets the attention of the teacher [7–9]. Even though by thinking creatively, one can solve problems without having to use existing stages especially when students face non-routine questions or open-ended questions [10–12]. When lecturers give issues, students have not been able to solve problems with various methods or algorithms that are diverse. Students still tend to solve problems according to the concept of solving taught by the lecturer. It is what causes problem-solving skills for students not yet optimal [8,11,13,14].

Many ways can be used to improve the ability to think creatively in students including using innovative learning such as realistic mathematics, discovery learning, predictive-explanatory, open-ended problem-based learning, practical problem posing learning can improve students' creative thinking skills [15–20]. With this innovative learning, creativity as the output of the creative thinking process will produce new solutions that are different from the previous ones [6]. One model of learning that can be applied to foster student creative ideas is Research-Based Learning [21]. In universities, the concept of research-based learning is a combination of learning with the results of research or publications conducted by lecturers so that learning becomes more contextual because students are involved in the construction of knowledge manifested in the form of learning experiences [22–24].

Research-based learning is based on a constructivist philosophy that includes four aspects, namely learning that builds students' understanding, learning by developing prior knowledge, learning which is a process of social interaction and meaningful learning that is achieved through real experience [25]. Research activities in research-based learning can provide space for students to get creative ideas. Students can formulate the knowledge they have by the problems they face so that they can form a resolution strategy and eventually be able to solve the problem. Creative students view problems not just from one point of view. Students can find various settlement solutions. Thus students have created. Also, research-based learning can also foster student skills in conducting research [26]. Research skills that can grow and develop in students include creative thinking skills [22,27]. Various studies have shown that effective research-based learning is used to improve and develop learning outcomes and processes [12,28], but not many can think creatively. Thus the purpose of writing this article is to find out the improvement of students' creative thinking skills by using research-based learning.

2. Method

This type of research is an experiment with the design of One-Group Pretest-Posttest Design. One-Group Pretest-Posttest Design involves three steps: first managing the pretest to measure the dependent variable, the second applying the experimental treatment X on the subject, and the third managing the posttest to measure the dependent variable [29–31]. Where treatment is used is research-based learning, while the dependent variable used is the skills of thinking creatively.

The subjects used in this study were 30 students of Mathematics Education at the University PGRI Madiun (UNIPMA) who were taken using a purposive sampling technique. Purposive sampling that is taking selected samples using specific criteria so that the subject is relevant and meets the requirements to be used in this study [29,32,33], while considering the nine subjects because this research is part of a worksheet development study that uses development research methods that refer to in the five-step cycle model, namely analysis, design, development, implementation, evaluation [34]. Where in this article the language is only at the implementation stage of the mathematical, statistical worksheet that has been developed in the previous steps.

The instruments used in the study were in the form of tests consisting of two questions. Students are asked to complete the two items to find out their creative thinking abilities. This form of questioning for creative thinking asks students to make an event in their daily lives related to opportunities. The materials requested are events that occur from the identification of students on the types of activities in everyday life. In this study, mathematical creative thinking ability was measured using fluency indicators: the ability to express more than one answer / idea to a particular mathematical problem or situation with lancer, flexibility: the ability to produce varied answers / ideas or change other ways / thoughts, elaboration: ability to make details of plans in particular, and originality that refers to the ability of students to answer problems with different answers and correct values or one answer that is not usually done by students at their level of development: the ability to detail ideas in detail [8,11,35–38]. There is a tendency for students to think creatively in a low category if it is obtained less than 55, high is more than 75, and moderate if it is in the range of both [39].

Research-based learning can improve the ability to think creatively if (1) students experience an increase of at least 55%, and (2) the average creative thinking ability is more than 55. The data analysis technique uses t-test one sample and N-Gain [40,41]. On sample, t-test aims to determine differences in creative thinking skills before and after using research-based learning. N-Gain seeks to identify the increasing interest in learning mathematics before and after using research-based learning. The average N-gain is defined as $\langle g \rangle = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$, where the maximum score (S_{max}) has been scaled to 100 [42], In this study, the categorizations used were: low if $\langle g \rangle < 0.30$, medium if $0.3 \leq \langle g \rangle \leq 0.70$, and high if $\langle g \rangle > 0.70$ [43].

3. Result and discussion

Research-based learning is the relationship between classroom learning and research [44], dalam penelitian ini mahasiswa dibagi menjadi beberapa kelompok yang beranggotakan 5 mahasiswa. Setiap kelompok. Setiap kelompok diminta mencari peristiwa dalam kehidupan sehari-hari yang berkaitan dengan peluang dan

mempresentasikan hasil peristiwa yang berbeda-beda tiap kelompoknya.Salah satu hasil pekerjaan mahasiswa yaitu kemungkinan munculnya mata dadu satu pada pelemparan sebuah dadu. Dari peristiwa itu ada satu kelompok yang meperagakan menggunakan dadu. Dosen bertugas menjelaskan ulang berbagai jawaban yang belum jelas.

Table 1. Score pre-test, post-test and N-Gain

No	Pre-tes	Pos-tes	N-gain	No	Pre-tes	Pos-tes	N-Gain
1	10	75	0.72	16	50	65	0.30
2	75	85	0.40	17	75	75	0.00
3	50	75	0.50	18	15	75	0.71
4	50	80	0.60	19	30	75	0.64
5	25	80	0.73	20	50	65	0.30
6	50	75	0.50	21	50	80	0.60
7	50	75	0.50	22	50	75	0.50
8	75	65	-0.40	23	50	85	0.70
9	50	75	0.50	24	50	60	0.20
10	50	75	0.50	25	75	60	-0.60
11	15	75	0.71	26	50	60	0.20
12	30	75	0.64	27	50	60	0.20
13	50	75	0.50	28	75	75	0.00
14	50	70	0.40	29	30	60	0.43
15	75	85	0.40	30	35	90	0.85

Table 1, showed that from the calculation of the difference in critical thinking skills between pre-test and post-test it was found that 87% (26 students) experienced an increase in creative thinking skills, 7% (2 students) had a creative thinking ability score down, and the rest of the creative ability did not experience change. These results indicate that one of the requirements set out in the previous section, namely students who experience an increase in creative thinking skills are at least 55% fulfilled because using research-based learning shows an increase of 87%.

From the table 2, after calculating creative thinking skills both before and after using research-based learning, it was found that the mean ability of creative thinking before using research-based learning was 48, minimum score was 10, a score was maximum 75, and variance was 18.32. The ability to think critically after using research-based learning obtained a mean of 73.33, a minimum score of 60, a maximum score of 90, and a variance of 8.24. While N-Gain is obtained that the way is 0.41, the minimum gain is -.60, the maximum gain is 0.85, and the variance for the gain is 0.32.

Table 2. Description Statistic of Creative Thinking Skill

	Pre-tes	Pos-tes	N-Gain
Mean	48	73.33	0.41
Variance	18.32	8.24	0.32
Minimim	10	60	-0.60
Maximum	75	90	0.85

From the results of the calculation of one sample t-test in table 3, it was found that the ability to think creatively before using research-based learning was -2,093 with a significance coefficient of 0.045. It is shown that the average capacity of creative thinking of students is not 55, but below 55 by looking at the average ability to think creatively before using research-based learning by 48. Besides that, it can evaluate the ability to think creatively after using research-based learning at 12,194 with a significance coefficient of 0.000. It is shown that the average student's creative thinking ability is not 55, but is above 55 by looking at the average creative thinking ability after using research-based learning at 90. The results of this calculation

indicate that experiential research-based learning (using statistical tests) can increase the capacity to think creatively.

Table 3. Output statistic one-sample t-test

	Test value = 55		
	t observations	df	Sig.
Pre-test	-2,093	29	0.045
Post-test	12.194	29	0.000

The results of this study indicate that before using research-based learning, students 'creative thinking abilities are below 55. It is shown that students' creativity in solving statistical problems is not optimal or still low. In connection with this condition, the students' creative thinking ability needs to be improved so that the goals in mathematics learning can be achieved so that students can face the challenges faced in the 21st century [1,5,7–9]. By using a combination of research and learning, students' creative thinking skills increased to 73.33. Although students' cognitive thinking ability after using research-based learning is still in the moderate category, this increase in capacity reaches 25.33. If you look at the average N-Gain of 0.41, then increasing the ability to think creatively using research-based learning is very significant because this coefficient is in the medium category.

The process of creative thinking is a process that combines logical thinking used to verify these ideas into a creative solution, and divergent thinking is applied to find ideas for solving problems [7,8]. Efforts to improve the ability to think creatively can be made regarding material, learning processes, improvement, and support of infrastructure. In the learning process, a way is needed to encourage students to understand the problem, so that students' creative thinking skills in solving problems they face can improve. One of the learning processes used to improve the ability to think creatively is research-based learning.

Research-based learning is authentic problem-solving learning with the point of view of problem formulation, problem-solving, and communicating the benefits of research results. Research-based learning is designed according to the construct, where students can develop the ability to think critically, analyze and evaluate a problem [45]. Research-based learning can provide new experiences for students. This experience is a theoretical experience in the classroom and direct experience in everyday life [46].

In this regard, theoretically, research-based learning can improve students' ability to think creatively. In addition, by using research-based learning some of the benefits obtained include (1) increasing the meaningfulness of the course to be more contextual through the presentation of research results, (2) strengthening students' thinking abilities as researchers, (3) completing learning through internalization the value of research, practice, and research ethics by involving research, (4) improving the quality of research at PT and engaging students in research activities, (5) increasing student understanding of the development of a science through continuous research, (6) increasing knowledge of roles research in innovation encourages students always to improve the quality of learning in general [25].

4. Conclusion

Research-based learning empirically can improve students' creative thinking skills in taking mathematical statistics. It can be seen from the number of students who experienced an increase in creative thinking skills before and after using research-based learning at 87% with mean N-Gain of 0.41 in moderate categories, and the average ability to think creatively after using research-based learning at 73.33. Increasing the ability to think creatively is because research-based learning combines theoretical experience in the classroom and direct experience in everyday life so that students can construct the problems faced.

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