The effect of group mentoring learning on student’s creativity in solving partial differential equations problems

1Ratna Yulis Tyaningsih, 1Nourma Pramestie Wulandari, 1Junaidi, 1Deni Hamdani, and 2Sumbaji Putranto

1 Universitas Mataram, Jl. Majapahit No. 62 Mataram, Indonesia
2 Universitas Islam Negeri Sunan Kalijaga, Jl. Marsda Adisucipto Yogyakarta, Indonesia

E-mail: nourmapw@unram.ac.id

Abstract. The Group Mentoring Learning Model is a learning model that emphasizes group collaboration by using the methods of teaching one another, demonstrating, and modeling the newly acquired knowledge and skills. The core stages of the GML Model include orientation, discussion, comparing, mentoring, creating, and evaluation. The type of questions used in this study is Middle Ended, which is a problem with one solution and many solution strategies. The purpose of this study was to determine the effectiveness of the Group Mentoring Learning Model on student creativity in solving partial differential equation problems. Data collection techniques used in this study were observation, questionnaire, pretest, and posttest. The data obtained were then analyzed using paired t-sample tests. The subjects of this study were students of Mathematics Education at Universitas Mataram Semester VI Academic Year 2019/2020. The results of data analysis showed that (1) the percentage of the implementation of the GML model for all stages was 81.01% and it was categorized as quite good, (2) the positive response of students in the implementation of learning using GML with a total average of 2.95 and included in the fairly good category, (3) the effectiveness of the GML model in increasing student creativity in solving partial differential equation problems with N-Gain value = 56.5031% which is categorized as quite effective, and (4) there are differences in the level of student creativity before and after applying learning with the Group Mentoring Learning Models with t count = -15.875 < -2.056 = t table. Based on the results of the study it was concluded that the application of the Group Mentoring Learning model was effective on student creativity in solving Partial Differential Equations problems.

1. Introduction

One of the demands of 21st-century education is that students must have skills, known as 4C, namely critical thinking skills, creativity, communication, and collaboration. Among 4C, one of the important skills students have is creativity. Based on data from the Global Creativity Index (GCI) in 2019, Indonesia's creativity index is ranked 85 out of 129 countries so that the level of innovation and creativity in Indonesia is still quite low because there have been no significant changes from previous years. Therefore, creativity is one of the goals of national education [1]. Graduate learning achievements are achieved through a learning process that prioritizes the development of creativity, capacity, personality, and needs of students, as well as developing independence in seeking and finding knowledge [2]. Creativity is the ability of a person to produce new ideas from existing ideas [3]. It would be better if students could create innovations from the
knowledge they have learned. Some ways to develop creativity are (1) exchanging ideas with others so that new ideas can be obtained by collaboration, (2) being open and responsive in seeing new views, (3) using technology as a forum for developing new ideas and completing problem practically. Creativity is the ability of students to participate in learning activities to find and use new ideas that are unusual but still logical and rational [4].

Creativity can be seen from two aspects, namely cognitive aspects in the form of the ability to think creatively and affective aspects in the form of creative attitudes. Several previous studies have divided the creativity component in terms of cognitive aspects into 5 indicators, namely fluency, flexibility, originality, elaboration, and evaluation [5-10]. Meanwhile, the creativity component when viewed from the affective aspect consists of imaginative, having broad interests, having initiative, being independent in thinking, confident, open to new experiences, confident, dare to take risks, and brave in conviction and conviction [11]. Students are called creative if they can create new strategies or modify existing strategies, submit arguments about how those strategies will work for certain problems and those strategies are not suitable for use [12].

The cause of the level of student creativity is very low is students only focus on answers to exercises in books that have been studied without developing more ideas and ideas [13]. However, not only students are required to be creative, but also lecturers. Lecturers must be clever in choosing the right model to be applied by the characteristics of the material to be delivered. Another opinion is that student creativity is not the top priority in learning objectives because lecturers often only give questions by emphasizing aspects of the truth of the answers without regard to the creativity that arises. Several factors that cause the difficulty of developing student creativity [14]. The main cause is the fault of educators. Lecturers still dominate learning activities. The method used does not involve students actively. As a result, truly intelligent students will find it difficult to express their ideas. An effective way to overcome this is to practice learning independence and facilitate the development of student ideas through a quality learning process.

The role of parents in supporting children's creativity, namely by supporting children's opinions and encouraging them to express them, allowing children to think and imagine, inviting children to make their own, develop togetherness with children, encourage children's independence, and create an environment that supports creative children become productive children [15]. Creativity can be enhanced by creating a learning environment that requires students to be active [16]. The main component in creativity is rich in science and skills [17]. Increased student creativity is influenced by learning that is carried out. The learning applied must be of high quality and by 21st Century learning. To support the achievement of 21st Century learning demands, lecturers must be able to create an enjoyable learning atmosphere and adequate learning facilities. An enjoyable learning atmosphere can increase students' creativity and activeness according to their abilities optimally [18]. Involving students to be active and creative in effective and fun learning is one of the applications in ideal learning by applying Group Mentoring Learning.

Group Mentoring Learning is a type of cooperative learning model that is the development of Project Based Learning. In cooperative learning, the model contains syntax that aims to develop discussion and communication skills so that students can exchange knowledge and information, develop critical thinking skills, provide opportunities for self-performance, and assess the abilities and roles of each themselves and others [19]. Group Mentoring Learning is a learning model that emphasizes teamwork to teach one another, demonstrate, and model the knowledge acquired to build quality learning activities, build equitable understanding, and increase student creativity [20]. Henceforth the Mentoring Learning Group is called GML. The six stages of learning activities that are reflected in the syntax of the GML Model are (1) Orientation; Introduction to ill-structured problems, (2) Group Discussion; Studying and solving problems in groups, (3) Comparing; comparing various answers/methods obtained in groups, (4) Mentoring; teaching each other between group members the knowledge/information obtained, (5) Creating; present the results of discussions or new ideas, and (6) Evaluation; evaluating the learning that has been done [20].
2. Method

This study uses a quantitative approach. The research method used was one group pretest-posttest design. The subjects in this study were the sixth-semester mathematics education students who took partial differential equation courses in the 2019/2020 school year, totaling 27 people. Details of the data collection instruments in this study are presented in Table 1.

| Instrument       | Recorded data                           | Data source |
|------------------|-----------------------------------------|-------------|
| Observation sheet| Execution data of the GML model          | observer    |
| Questionnaire    | Student responses about the implementation of learning. | respondent |
| Pretest & Posttest| Student Creativity Value                | respondent |

The hypothesis formulation in this research is

\[ H_0 \text{ there is no average difference between the value of creativity (pretest) before applying the GML model and the value of creativity (posttest) after applying the GML model in solving the problem of partial differential equations} \]

\[ H_1 \text{ there is an average difference between the value of creativity (pretest) before applying the GML model and the value of creativity (posttest) after applying the GML model in solving the problem of partial differential equations} \]

The division of N-Gain acquisition categories in the form of a percent (%) refers to Table 2 as follows.

| Percentage (%) | Interpretation |
|----------------|----------------|
| \( NGain > 75 \) | Effective |
| \( 55 < NGain \leq 75 \) | Effective enough |
| \( 40 < NGain \leq 55 \) | Less effective |
| \( NGain \leq 40 \) | Ineffective |

Table 3. Guidelines for Interpretation of Correlation Coefficients

| Coefficient interval | Correlation Level |
|----------------------|-------------------|
| \( r \leq 0.2 \)     | Very weak         |
| \( 0.2 < r \leq 0.4 \) | Weak             |
| \( 0.4 < r \leq 0.6 \) | Neutral         |
| \( 0.6 < r \leq 0.8 \) | Strong           |
| \( 0.8 < r \leq 1 \) | Very strong       |

The level of student creativity can be seen based on 5 characteristics, namely fluency, flexibility, originality, elaboration, and evaluation as shown in Table 4.

| Level                | Characteristics                                                                 |
|----------------------|----------------------------------------------------------------------------------|
| Level 4 (Very creative) | The students’ answer fulfill the aspects of fluency, flexibility, originality, elaboration, and evaluation |
| Level 3 (Creative)   | The students’ answer does not meet one aspect of fluency, flexibility, originality, elaboration, or evaluation |
3. Result and Discussion

3.1 Analysis results from the implementation of the GML model

The GML model syntax consists of 6 stages, namely orientation, discussion, comparison, mentoring, creating, and evaluating. In these 6 stages, there are several creative activities, including synthesizing ideas, building creative ideas, developing creative ideas, and affirming. Therefore the implementation of the syntax in these 6 stages will be presented in Figure 1 as follows.

![Figure 1. Percentage of Workability of the GML Model](image)

Figure 1 shows that the average level of implementation of the GML Model for all stages is 3.25 or if it is a percentage of 81.01% so that it can be concluded that the implementation of the GML model is included in the quite good category with the distribution as shown in Figure 1.

3.2 Results of analysis of questionnaire responses

A summary of the results of the questionnaire response analysis of learning activities using the GML Model is presented in Table 5.

| No. | Statements                                                                 | Average |
|-----|-----------------------------------------------------------------------------|---------|
| 1.  | The way the lecturer opens and closes the lesson is fun.                    | 3.04    |
| 2.  | Lecturers motivate in interesting ways                                       | 2.93    |
| 3.  | Class discussion activities are fun.                                         | 3       |
| 4.  | During learning, I am free to issue ideas or opinions.                      | 2.93    |
| 5.  | During the study, I was free to ask questions.                              | 2.89    |
| 6.  | The way the lecturer responds to ideas or opinions from students is fun.    | 3.07    |
| 7.  | I enjoy discussing with other students in a group                           | 2.89    |
| 8.  | In working on the problems, I am free to use the method that I like.        | 3       |
| 9.  | I was challenged to solve the problems given.                               | 2.81    |
10. I always want to know other ways that are easier and more precise than the way that I use.

11. I like to discuss answers or other methods with friends so that I have many answers or ways to solve them.

12. I enjoy interacting with other students and comparing the answers I get with those of other students.

13. I like to teach other students about the results of the work I get and explain things that other students don't understand.

14. The presentation of the material feels interesting and fun.

15. I like to solve problems in many ways or many answers, after following this way of learning.

16. I like to follow the learning with an atmosphere that is not rigid and fun.

**Total Average**

Table 5 shows that the response of students to learning using the GML Model syntax of 2.95 with quite a good category. This means that there is a positive response to the application of learning with the GML Model.

### 3.3 Results of analysis of creativity values

The data generated in this study were quantitative data that were analyzed using statistical tests which were divided into 2 stages, namely the initial and final stages. The initial stage consists of tests of normality and homogeneity, while the final stage consists of t-tests, normalized gain tests, and analysis of student response questionnaires. The data analysis tool used is IBM SPSS Statistics 24. The results of normality test data are presented in Table 6 as follows.

**Table 6. Tests of normality**

| Type of test | Shapiro-Wilk Statistic | df | Sig. |
|--------------|------------------------|----|------|
| Pretest      | 0.946                  | 27 | 0.175|
| Posttest     | 0.961                  | 27 | 0.394|

Many of the data tested in this study are 27 (less than 50) so that the normality test uses Shapiro-Wilk. Based on Table 6, concluded that the value of Sig. pretest = 0.175 > 0.05 = α as well as the Sig. posttest = 0.394 > 0.05 = α then according to the basis of decision making in the Shapiro-Wilk normality test it can be concluded that the data are normally distributed.

**Table 7. Test of homogeneity of variance**

| Test               | Levene Statistic | df1 | df2 | Sig  |
|--------------------|------------------|-----|-----|------|
| Based on Mean      | 0.395            | 1   | 52  | 0.532|
| Based on Median    | 0.296            | 1   | 52  | 0.589|
| Based on Median and with adjusted df | 0.296 | 1 | 49.252 | 0.589|
| Based on trimmed mean | 0.414 | 1   | 52  | 0.523|

Based on Table 7 shows that the value of Levene Statistics based on mean obtained 0.395 with Sig. equal to 0.532 > 0.05 = α then according to the basis of decision making in the homogeneity test it can be concluded that the data comes from a homogeneous population. The results of the N-Gain test can be seen in Table 9.
Table 8. Description of N-Gain percentage

| Statistic               | N-Gain Percentage | Std. Error |
|-------------------------|-------------------|------------|
| Mean                    | 56.5031           | 3.52283    |
| 95% Confidence Interval | Lower Bound       | 49.2618    |
| 95% Confidence Interval | Upper Bound       | 63.7443    |
| 5% Trimmed Mean         | 55.7853           |            |
| Median                  | 55.5556           |            |
| Variance                | 335.079           |            |
| Std. Deviation          | 18.30517          |            |
| Minimum                 | 25                |            |
| Maximum                 | 100               |            |
| Range                   | 75                |            |
| Interquartile Range     | 18.06             |            |
| Skewness                | 0.757             | 0.448      |
| Kurtosis                | 0.840             | 0.872      |

Based on the calculation results of the N-Gain test in Table 8, it shows that the average N-Gain (%) in this study was 56.5031%. N-Gain value of at least 25% and a maximum of 100%. According to the interpretation of effectiveness categories in Table 2, N-Gain = 56.5031% are in the category of quite effective. This means that the application of the GML model is quite effective in increasing student creativity in solving Partial Differential Equations problems.

Table 6 shows that the research data is normally distributed, so to find out the comparison of the average value of students' creativity before and after the application of the GML Model, researchers used a parametric statistical analysis that is paired sample t-test. As with the basic rules in parametric statistical analysis, the main requirement for paired sample t-test can be done is a normally distributed research data.

Table 9. Paired samples statistics

|       | Mean | N  | Std. Deviation | Std. Error Mean |
|-------|------|----|----------------|-----------------|
| Pair 1| Pretest | 55.93 | 27 | 14.347 | 2.761 |
|       | Posttest | 79.44 | 27 | 12.583 | 2.422 |

Table 9 shows a summary of descriptive statistical results from the two samples studied, namely Pretest and Posttest. For the pretest value obtained an average of 55.93 and the posttest value obtained an average of 79.44. The number of respondents used as research samples were 27 people. Because the average value of student creativity at pretest = 55.93 <79.44 = posttest, then that means descriptively there is a difference in the average value of creativity between pretest and posttest. Furthermore, to prove whether the difference is truly significant or not, it is necessary to interpret the results of the paired sample t-test contained in Table 10 and Table 11.

Table 10. Paired samples correlations

|       | N | Correlation | Sig. |
|-------|---|-------------|------|
| Pair 1| 27| .844        | .000 |

Table 10 shows the results of the correlation test between the two data namely pretest and posttest. Based on Table 10 it is known that the correlation coefficient is 0.844 because this test is a paired sample or correlated with the Sig. 0.000. Because of the value of Sig. 0.000 <0.05 = α, it can be said that there is a significant correlation between the pretest and posttest variables. Based on the interpretation of the
correlation coefficient guidelines in Table 3 the value of \( r = 0.844 \) has a very strong correlation level. Thus it can be concluded that the level of correlation between the pretest and posttest variables is very strong.

### Table 11 Paired samples test

| Paired Differences | t    | df | Sig. (2-tailed) |
|-------------------|------|----|----------------|
|                   | Std. Deviation | Std. Error | 95% Confidence Interval of the Difference | Lower | Upper |
| Mean              | Mean    | df  |                 |       |       |
| Pretest           | 7.698   | 1.481 | -26.564 -20.473 | -15.875 | 26    | 0.000 |
| Posttest          | 23.519  |       |                  |       |       |       |

Table 11 contains information about the mean paired differences in the amount of -23.519. This value is obtained from the difference between the mean pretest and posttest that is 55.93 - 79.44 = -23.51 and the difference between -26.564 to -20.473. Table 11 shows that the \( t \) value is negative, that is -15.875 while the \( t \) table with \( df = 26 \) is 2.056. Because \( t \) count = -15.875 < -2.056 = \( t \) table then \( H_0 \) is rejected and \( H_1 \) is accepted.

In addition to using the value of \( t \), can also determine decisions with Sig value. Table 11 shows that the value of Sig. (2-tailed) = 0.000 < 0.05 = \( \alpha \). Thus it can be concluded that there is an average difference between the value of creativity (pretest) before applying the GML model and the value of creativity (posttest) after applying the GML model in solving the problem of partial differential equations.

4. **Conclusion**

The Mentoring Learning Group model influences student creativity seen from (1) the percentage of the implementation of the GML model for all stages was 81.01% categorized as quite good, (2) the positive response of students in the implementation of learning using GML with a total average of 2.95 categorized as good, (3) the effectiveness of the GML model in increasing student creativity with N-Gain value = 56.5031% categorized as quite effective, and (4) there are differences in the level of student creativity before and after being treated using observation sheets and tests (pretest and posttest) with \( t \) count = -15.875 < -2.056 = \( t \) table. The great increase in student creativity is seen from the aspects of fluency, flexibility, and originality. Based on research that has been done, the researcher suggests that other researchers who want to develop research on creativity should combine the GML model with e-learning so that the blended learning model can be developed.

**Acknowledgment**

The authors would like to thank profusely to the Mathematics Education Department, Faculty of Teacher Training and Education, Universitas Mataram, which has supported this research. The author also thanks all those involved in this research and publication.

**References**

[1] Safitri I, Wijayanti P and Masriyah 2018 The creativity of Prospective Teachers in Mathematical Patterns Problem Solving Based on Emotional Intelligence *Journal of Physics: Conference Series* **1108** 012116

[2] SN-DIKTI 2015 *Standar Nasional Pendidikan Tinggi* (Indonesia: Permenristekdikti No. 44 Tahun 2015)

[3] Cahyono A, Slamet I and Usodo B 2019 Mnemonic on the logarithm of the form of creativity from 21st-century skills *Journal of Physics: Conference Series* **1188** 012097
[4] Gunawan G, Suranti N M Y, Nisrina N, Herayanti L and Rahmatiah R 2018 The effect of virtual lab and gender toward students’ creativity of physics in senior high school Journal of Physics: Conference Series 1108 012043

[5] Tabach M and Friedlander A 2013 School mathematics and creativity at the elementary and middle-grade levels: how are they related? ZDM Mathematics Education 45 pp 227-38

[6] Kattou M, Kontoyianni K, Pitta-Pantazi D and Christou C 2013 Connecting mathematical creativity to mathematical ability ZDM Mathematics Education 45 pp 167-81

[7] Leikin R and Lev M 2013 Mathematical creativity in generally gifted and mathematically excelling adolescents: What makes the difference? ZDM Mathematics Education 45 pp 183-97

[8] Bonotto C 2013 Artifacts as sources for problem-posing activities Educational Studies in Mathematics 83 pp 37–55

[9] Van Harpen X Y and Presmeg N C 2013 An investigation of relationships between students’ mathematical problem-posing abilities and their mathematical content knowledge Educational Studies in Mathematics 83 pp 117-32

[10] Voica C and Singer F M 2013 Problem modification as a tool for detecting cognitive flexibility in school children ZDM Mathematics Education 45 pp 267-79

[11] Ismayani A 2016 Pengaruh penerapan STEM project-based learning terhadap kreativitas matematis siswa SMK Indonesian Digital Journal of Mathematics and Education 3 4 pp 264-72

[12] Alamsyah N 2017 Penerapan pendekatan saintifik untuk meningkatkan kreativitas dan hasil belajar siswa dalam mata pelajaran IPA JP (Jurnal Pendidikan): Teori dan Praktik 1 1 pp 81-8

[13] Setyowidodo I, Sutanto, Handayani A D and Mahmudi H 2019 Problem based learning in mechanical engineering to train student’s creativity Journal of Physics: Conference Series 1280 052072.

[14] Andriania A and Sagala P N 2020 The use of Mixed Apps as accommodation of mathematical student creativity Journal of Physics: Conference Series 1462 012027

[15] Gunawan G, Sahidu H, Susilawati S, Harjono A and Herayanti L 2019 Learning Management System with Moodle to Enhance Creativity of Candidate Physics Teacher Journal of Physics: Conference Series 1417 012078

[16] Pamungkas A, Subali B and Linuwih S 2017 Implementasi model pembelajaran IPA berbasis kearifan lokal untuk meningkatkan kreativitas dan hasil belajar siswa Jurnal Inovasi Pendidikan IPA 3 2 pp 118–27

[17] Astuti R K 2016 Model pembelajaran berbasis masalah untuk meningkatkan kreativitas siswa dalam membuat proyek sains PSEJ (Pancasakti Science Education Journal) 1 1 pp 50–9

[18] Nurudin M, Riyadi R and Subanti S 2019 Cooperative learning model using AFL to learn geometry based on creativity perspective Journal of Physics: Conference Series 1188 012008

[19] Tyaningsih R Y 2014 Pengembangan model group mentoring learning (GML) berbasis open ended pada materi barisan dan deret untuk siswa sma/smkn kelas 10 (Malang: Universitas Negeri Malang)

[20] Hussen S, Dafik, Monalisa L A, Murtikusuma R P and Oktavianingtyas E 2019 Combinatorial thinking and creativity skills in solving a colored-square paving decoration problem Journal of Physics: Conference Series 1211 012062