Student’s mathematical creative skill using interactive application media based on collaborative learning

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Abstract. Completing Linear Equation System by Elementary Row Operations is a fairly complex problem in mathematics. Someone who is faced with this problem can be measured his creative skills. The fact shows that their creative skills are still relatively low. Therefore learning based collaborative using interactive application media will be applied. This research type was a mixed method, which combines quantitative and qualitative research. The Quantitative method is used to analyze student learning outcomes, while the qualitative methods is used to analyze students' creative abilities. Respondents involved in this study consisted of three classes, consisting of two experimental classes and one control class which is each class consisting of 36 students. The objects of this research was the students of SMAN 1 Kencong Jember, who were selected three class as research samples, therefore XI MIPA 1 class as the first experimental class and XI MIPA 2 class as the second experimental class and at last XI MIPA 3 class as the control class. The research results indicated that the pre-test of three classes was homogeneous. While the post-test result shows that the average of the three classes is significantly different. This is indicated by the value of one way ANOVA (p = 0.05), it was found that collaborative learning using interactive application media as part of the developed tool can provide better results in terms of creative thinking abilities. Interactive application media as part of collaborative-based learning tools can provide positive stimulation to students so that students' creative thinking abilities increase. The tool developed in this study was also declared valid, practical and effective.

1. Introduction
Education is a conscious and systematic effort made by people who are entrusted with the responsibility to influence students to have the character and behaviour in accordance with the ideals of education [1]. Educational skills and technological mastery must be mastered in facing and preparing for challenges in the 21st century era. Student center learning, education based collaboration, contextual learning, and school are integrated with environment are 4 basic principles of learning in
21st century [2]. The main skills that must be have is critical thinking, creative, communication, and collaboration [3].

In modern learning, students should not only listen to lectures as in conventional learning, where students simply swallow raw and accept all the teacher's explanations without any activeness from students or teacher centered, but students must process what they hear and see into a meaningful single unit [4]. Information technology influences the development of learning media [5]. Technology based learning media is important in mathematics learning [6]. In the process of learning mathematics, media can generate desire, motivation and stimulation. The goal is to make learning communication effectively, so the planned learning aim is reached [7]. Learning activeness can be seen from active involvement between teachers and students [8].

Collaboration is the process of linking the learning context and student personality, prior experience and knowledge and learning skills [8, 9]. The process of successful collaboration is also a process of individual student interpretation of the learning situation that is part of a shared meaning [11, 12]. Collaboration has been proven to activate special learning mechanisms that cannot be triggered by working individually [13, 14]. Collaborative learning through Lesson Study and then integrated with the use of technology is an effective action to increase student creativity in the classroom.

Creative thinking can be described as the ability of students to generate many possible answers and ways to solve problems [15]. There are four criteria of think creatively proposed by Munandar: fluency, flexibility, originality and elaboration [13]. Student’s creative thinking can improve with innovative method [13]. Febriyanti et al's research stated that students with TBK 1, TBK 2, TBK 3 and TBK 4 showed students in accordance with the indicators of creative thinking, and TBK 0 were students without 4 indicators of creative thinking. Hobi et al's research (2018) stated that open ended-based collaborative learning aims to help develop students' creative activities with simultaneous problem solving. The results of the study generally state that collaborative learning results in better achievement than conventional learning.

This study also refers to the application of Monsakun from [18], which contains a solution within format of mathematical stories question for elementary school level students.

Based on the explanation above, the development of collaborative learning tools using interactive application media is a combination that can be used in the process of learning mathematics in schools, with the hope that the process of learning mathematics in schools will improved, students can be creative and active in it.
2. Method

The method in this research is combination research or mixed methods. [16] states that the combined research method (mixed methods) is a research method that combines or merge quantitative methods with qualitative methods to be used together in a research activity, in order to obtain more comprehensive, valid, reliable and objective.

This study aims to develop collaborative learning tools using interactive application media and discover their effects on students' creative thinking abilities. Thus, this type of research is to combine 2 types of research, those are development research and experimental research. This combined research method is used to test the effectiveness of the process and the results of a particular product. The effectiveness of the process was investigated by qualitative methods and the effectiveness of the results was tested by experimentaton.

Development research uses the design of the development of learning tools developed by Thiagarajan, Semmel and Semmel. Thiagarajan's model in [17] is known as 4-D (Four-D Models). This research implemented in four stages, there are the defining stage, the design stage, the development stage and the disseminate stage. Whereas in experimental research, the chosen research design is the one that most allows the researcher to control other variables that are thought to have an influence on the dependent variables.

The combination method model used is the triangulation model, which is a research method that combines qualitative and quantitative research methods by mixing the two methods equally. The method is used together, at the same time but independently to answer the problem formulation [16]. The qualitative method intended in this research is development research and the quantitative method is experimental research.

The subjects of this study were students of class XI of SMAN 1 Kencong. Sampling is done by homogeneity test. Data sources are from Mathematics teacher, validator, data taken from student creativity observation sheet, data from teacher observation sheet, student questionnaire data and student pre-post test result data.

Quantitative data analysis was performed by using data normality tests. If the data is normally distributed, then one way annova test was conducted.

This study uses three classes, which contains two experimental classes and one control class. For the experimental class 1 were treated X1, experimental class 2 was treated X2, and the control class was not treated any or using conventional learning.

| Table 1. Research design scheme |
|--------------------------------|
| Experiment Class | 0₁ | X₁ | 0₆ |
| Experiment Class | 0₂ | X₂ | 0₅ |
| Control Class | 0₃ | 0₄ |

Keterangan:

O₁, O₂, O₃: Pre-test
O₄, O₅, O₆: Post-test
X₁: The treatment uses collaborative learning without using LKS learning tools and interactive application media
X₂: The treatment uses collaborative learning by using LKS learning tools and Interactive Application Media

Qualitative data analysis was performed by analyzing the validity, practicality and effectiveness of the instrument. The analysis of students' creative thinking abilities was carried out using scoring in accordance with the criteria of creative thinking abilities namely fluency, flexibility, originality and elaboration.
3. Result and discussion

The results of instrument validation are based on the following tables.

1. Validity of instruments

The instrument validity criteria are based on the following table.

| Interval          | Validity |
|-------------------|----------|
| $3.5 \leq \overline{V_A} \leq 4$ | Very valid |
| $2.5 \leq \overline{V_A} < 3.5$ | Valid |
| $1.5 \leq \overline{V_A} < 2.5$ | Quite valid |
| $\overline{V_A} < 1.5$       | Invalid  |

Processing RPP validation score obtained an average of 3.90. Processing an LKS validation score obtained an average of 3.85. Processing the THB validation score obtained an average of 3.56. From the average results of RPP, LKS and THB validation, the instrument meets the validity criteria.

2. Practicality of instruments

The instrument validity criteria are based on the following table.

| Score       | Criteria     |
|-------------|--------------|
| $90\% \leq P_g$ | Very active |
| $70\% \leq P_g < 90\%$ | Active |
| $50\% \leq P_g < 70\%$ | Quite active |
| $P_g < 50\%$ | Inactive    |

From processing the validation score of the teacher's activity the percentage is 97.22%. This percentage is included in the very active category. From processing the validation score of student activities obtained a percentage of 96.53%. These percentages are included in the excellent category. The percentage of the results of the validation of the teacher's and student's activities shows that the instrument meets the practicality criteria.

3. Effectivity of instrument

The instrument validity criteria are based on the following table.

| Score              | Criteria     |
|--------------------|--------------|
| $90\% \leq P_s$    | Very good    |
| $70\% \leq P_s < 90\%$ | Good   |
| $50\% \leq P_s < 70\%$ | Quite good |
| $P_s < 50\%$       | Not good     |

From processing the validation score of the teacher's activity the percentage is 97.22%. This percentage is included in the very active category. From processing the validation score of student activities obtained a percentage of 96.53%. These percentages are included in the excellent category. The percentage of the results of the validation of the teacher's and student's activities shows that the instrument meets the practicality criteria.

| Score              | Criteria     |
|--------------------|--------------|
| $90\% \leq P \leq 100\%$ | Very good |
| $80\% \leq P < 90\%$    | Good        |
| $65\% \leq P < 80\%$    | Quite good  |
| $55\% \leq P < 65\%$    | Not good    |
From processing the validation score of the effectiveness of LKS was obtained a percentage of 91.67%, the percentage is included in the excellent category. Processing the validation score of student responses to LKS obtained a percentage of 93.75%. These results indicate that the instrument meets the effectiveness criteria.

Based on the four creative criteria of students and the post-test scores will be obtained later scores which will then look for the percentage of students' creative thinking abilities:

| Score            | Criteria          |
|------------------|-------------------|
| 90% ≤ NP ≤ 100%  | Very Creative     |
| 75% ≤ NP < 85%   | Creative          |
| 60% ≤ NP < 75%   | Quite Creative    |
| 55% ≤ NP < 60%   | Less Creative     |
| NP < 55%         | Not Creative      |

3.1 Analysis of Student Work

The following are the results of student work:

Student 1, He has developed his ability to think creatively by looking for steps to complete OBE, but the answers are still wrong.

Student 2, He has developed his creative thinking ability by finding steps to complete OBE, producing one correct answer.
Student 3, He has developed his ability to think creatively by looking for steps to complete the OBE, producing two answers, one right answer and one wrong answer.

Student 4, He has developed his creative thinking ability by looking for steps to complete OBE, producing two correct answers.

3.2 Interactive application media

This media was created as part of the development of devices to create collaborative learning that attracts students' interests, so students can be more interested, eager to follow the learning, understand the material more easily and enhance students' creative thinking abilities.

Figure 2 is an initial display that allows students to fill in their names, absentee numbers and classes. Figure 3 is a level selection page or question level starting at level 1 (questions with easy category) to level 5 (questions with difficult category). Figure 4 is a display of interactive application media level 1. At this level 1 students are only asked to write the matrix form of an SPLDV or SPLTV. This figure 5 shows level 2 which contains questions that are above the previous level. At this level students are asked to write the matrix form of SLPDV and SPLTV and determine the solution as shown in Figure 5, but at this level students are still given the completion options as shown in Figure 6. In Figure 7 students are given exercises as before but are not given the completion options, so students are asked to analyze it themselves or find ways of solving it themselves. From here students' creative thinking skills can be further honed.
3.3 Quantitative analyzing data
From students' pretest data, normality test was conducted based on Kolmogorov-Smirnov statistical values with a significance level of 5%, which obtained a significance level greater than 0.05 for 2
experimental classes and 1 control class so that it can be concluded that the data were normally distributed.

### Tests of Normality

| Groups          | Kolmogorov-Smirnov | Shapiro-Wilk |
|-----------------|--------------------|--------------|
|                 | Statistic | df | Sig. | Statistic | df | Sig. |
| Pre_Test        | Experiment Class 1 | .122 | 38 | .168 | .959 | 38 | .175 |
|                 | Experiment Class 2 | .080 | 36 | .200 | .979 | 36 | .711 |
|                 | Control Class     | .114 | 35 | .200 | .965 | 35 | .319 |

\(a\). Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Then a variant homogeneity test was conducted by using OneWay ANOVA with a significance level of 5%, obtained a significance level greater than 0.05 which means the data is homogeneous. If the homogeneity test shows that the significance level is less than 0.05, then the data is not homogeneous and a non-parametric test must be performed, namely the Mann-Whitney test.

### Test of Homogeneity of Variances

| Levene Statistic | df1 | df2 | Sig. |
|------------------|-----|-----|------|
| 1.694            | 2   | 106 | .199 |

The One Way ANOVA test was conducted which results in a significant level of 0.507 or greater than a significant level of 5% so that it can be concluded that there is no influence on students' creative thinking abilities.

### ANOVA

|              | Sum of Squares | df | Mean Square | F   | Sig |
|--------------|----------------|----|-------------|-----|-----|
| Between Groups | 206.031        | 2  | 143,016     | .563| .507|
| Within Groups  | 22189.217      | 106| 209,332     |     |     |
| Total         | 22455.248      | 108|             |     |     |

From the student's post test data also conducted a normality test based on Kolmogorov-Smirnov statistical values with a significance level of 5%, which obtained a significance level greater than 0.05 for 2 experimental classes and 1 control class so that it can be concluded that the data are normally distributed.
Then a variant homogeneity test was conducted by using OneWay ANOVA with a significance level of 5%, obtained a significance level greater than 0.05 which means the data are homogeneous. If the homogeneity test shows that the significance level is less than 0.05, then the data is not homogeneous and a non-parametric test must be performed, namely the Mann-Whitney test.

Furthermore, One Way ANOVA test will be conducted which results in a significant level of 0.000 or smaller than a significant level of 5% so that it can be concluded that collaborative learning using interactive application media has an influence on students' creative thinking abilities.

4. Conclusion
Based on the discussion and analysis of the data, it was found that collaborative learning using interactive application media as part of the developed tool can provide better results in terms of creative thinking abilities. Interactive application media as part of collaborative-based learning tools can provide positive stimulation to students so that students' creative thinking abilities increase. The tool developed in this study was also declared valid, practical and effective.

Acknowledgments
Authors would like to thank to Faculty of Teacher Training and Education (FKIP) Jember University, Supervisor and Headmaster of Senior High School 1 Kencong who have support writer writing this article.
References

[1] Munib A, Budiono and Suryono S 2004 *Pengantar Ilmu Pendidikan* (Semarang: UPT MKK UNNES)

[2] Fauziah E W 2019 Student’s Creative Thinking Skills in Mathematical Problem Posing Based on Lesson Study for Learning Community *IOP Conf. Series: Earth and Environmental Science* 243

[3] Tan J, Choo S, Kang T and Liem G 2017 Asia Pacif J.of Edu 37 pp 425-36

[4] Silberman L M 2006 *Actif Learning 101Cara Belajar Siswa Aktif, Edisi Revisi* (Bandung: Nusamedia)

[5] Putriani D 2017 Pengembangan Media Pembelajaran Berbasis Android Dengan Program Construct 2 Pada Materi Bangun Ruang Sisi Datar Untuk Siswa SMP Kelas 8 *Jurnal Pendidikan Matematika* 6(3)

[6] Aminudin N, Fauzi, Huda M and Hehsan A 2018 *Int. J. Eng. Technol.* 7 no 2 pp. 165-170

[7] Naz and Akbar R 2010 *J. Elem. Educ.* 18 pp 35-40

[8] Amelia C, Achmad A, and Marpaung R 2017 *J.Bio Terdidik* Vol 5 No 7

[9] Miyake N and Kirschner P 2014 The social and interactive dimensions of collaborative learning. 10.1017/CBO9781139519526.026.

[10] Punjambekar S 2006 Analyzing collaborative interactions: Divergence, shared understanding and construction of knowledge *Computers & Education* 47 pp 332-351

[11] Kirschner F, Paas R, Kirschner P and Janssen J 2011 Differential effects of problem-solving demands on individual and collaborative learning outcomes *Learning and Instruction* 21 pp 587–599

[12] Baker M 2015 Collaboration in collaborative learning *Interaction Studies* 16 pp 451-473

[13] Häkkinen P, Järvelä S, Mäkitalo-Siegl K, Ahonen A, Näykki P, and Valtonen T 2017 Preparing teacher-students for twenty-first-century learning practices (PREP 21): a framework for enhancing collaborative problem-solving and strategic learning skills *Teachers and Teaching: Theory and Practice* 23(1) pp 25-41

[14] Hobri and Nazareth E 2019 The Students Creative Thinking Ability in Accomplishing Collaborative Learning Based Open Ended Questions *IOP Conf. Series: Earth and Environmental Science* 243

[15] Martinez-Maldonado, Roberto, Collins, Anthony, Kay, Judy, Yacef and Kalina 2011 *Who did what? Who said that? Collaid: An environment for capturing traces of collaborative learning at the tabletop* Proceedings of the ACM International Conference on Interactive Tabletops and Surfaces, ITS

[16] Mihajlovic and Dejic 2015 *Prosiding of The 9th International MCG Conference* p 34-39

[17] Sugiyono 2017 *Metode Penelitian Kombinasi (Mixed Method)* (Bandung: Alfabeta)

[18] Hobri 2010 *Metode Penelitian Pengembangan (Aplikasi pada Penelitian Pendidikan Matematika)* (Jember: Pena Salsabila)

[19] Supianto A A 2017 *Process-based Assignment-Setting Change for Support of Overcoming Bottlenecks in Learning by Problem-Posing in Arithmetic Word Problems* (Japan: Hiroshima University)