The analysis on implementing discovery learning-based learning instruments in improving students’ creative and innovative thinking skills in completing problem of simple multiplication by using jaritmatika

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Abstract. Innovative creative thinking skills play an important role in supporting students in solving mathematical concepts, especially simple multiplication operational problem with Jarimatika. The researchers applied mixed methods with a sequential explanatory design. Research subjects were 28 students in the experimental class and 26 students in the control class. Data were collected through validation sheet, test, documentation, and prerequisite test. The research result indicated that after the implementation of Discovery Learning-based learning instruments, the percentage of students' innovative creative thinking for the control class was 11.54% for the very creative innovative level, 69.23% for the innovative creative level, 19.23% for the enough innovative creative level, and 0% for less or not innovative creative level. While the experimental class far exceeds the control class, 39% for the very creative innovative level, 57% for the innovative creative level, 4% for the enough creative innovative level, and 0% for less or not innovative creative level. The independent sample t-test score from the post-test shows that there is a significant difference between the control class and the experimental class with a t-count value of -4.965 with a significance value of 0.000. The significance value is smaller than the α value (0.05). This shows that there is an average difference between the control class and the experimental class after receiving treatment (post-test). The negative sign on the t-value indicates that the average experimental class is higher than the control class. It can be concluded that the application of Discovery Learning-based learning instruments can improve elementary school students' innovative creative thinking skills in solving simple multiplication operation problem with Jarimatika.

1. Introduction
In the 21th century, creativity and innovation are needed. Both teachers and students are required to have these skills. Learning designed by teachers must always be directed at the realization of innovative and creative skills. This aims to realize HOTS (Higher Order Thinking Skills) learning which is a necessity for life in the era of the industrial revolution 4.0.

Compiling a clear framework (learning model) is needed in developing learning innovation. We have to select the learning model that can use fun learning and can arouse the enthusiasm of students in ongoing learning [6]. In addition, the learning method applied should also be able to make learning more meaningful; so that, it can improve student learning outcomes. Learning model that is creative, innovative, and in accordance with the application of mathematics learning is discovery learning [8-9]. This learning is able to stimulate students in analyzing a problem faced in the learning process. Discovery learning model will help students eliminate doubts about a concept because it leads to final and definite truth [3-4].

Discovery learning model was developed by Jerome Bruner. Bruner considers that discovery learning is compatible with the active search for knowledge by humans and by itself gives the best results [11]. In order to succeed from challenges in math proficiency, students must work alone in
arithmetic by using Jarimatika strategy. The main element of understanding arithmetic is how to use Jarimatika, which is the student's awareness to manage it.

In helping the effectiveness of innovative creatives in overcoming math difficulties, especially on the topic of multiplication in elementary school, it is necessary to re-research in order to get the desired results, and to assist students in solving difficulties in mathematics subject. Creative and innovative skills will further develop if students have the opportunity to think broadly with action that must be stimulated to think outside of the existing habits, involve a new way of thinking, get the opportunity to convey new idea and solution, ask unusual questions, and try to propose an answer [7, 11, 20].

Based on the description above, indicators are needed to determine innovative creative thinking skills. We can see the indicators in the following table:

| Table 1. Indicators of creative and innovative thinking skills |
|-------------------------------------------------------------|
| **Indicator** | **Assessment** |
| High Productivity | Drawing more than one jarimatika along with the position of number on the finger and make the solution. |
| | Drawing one jarimatika along with the position of number on the finger and make the solution. |
| High Elasticity | Determining more than one jarimatika of the possible place of the finger position in jarimatika concept. |
| | Determining one jarimatika of the possible place of the finger position in jarimatika concept. |
| High Originality | Writing the point function and fill weight of the finger or segment that is in the jarimatika image that has been done. |
| | Writing the finger function from jarimatika that has been done. |
| | Unable to write finger function and position of jarimatika on the image that has been done. |
| High Sensitivity | Re-checking the results of the work in the form of image that mentions finger function and position on finger that has been done more than / equal to twice |
| | Re-checking the results of the work in the form of image that mentions finger function and position on finger that has been done once. |
| | Re-checking the results of the work in the form of function and position on the finger that has been done once. |
| | Do not do re-checking |

Based on the introduction described above, the objectives of this research were to develop discovery learning-based learning instruments and to analyze the effect on students' innovative creative thinking skills in solving simple multiplication problems by using Jarimatika. In addition, the portrait phase of innovative creative skills obtained from analyzing students’ answers and interviews conducted by the authors with the research subject as the sample were also analyzed.

2. Method

The research design used was a mix method research design [5]. The mixed research design in this study used a triangulation design. Exactly, mixed method research aims to simultaneously collect quantitative and qualitative data, combine data, and use the results to understand research problems. For the experimental process, it can be seen in Table 2.

| Table 2. Pre-test and post-test control group design |
|---------------------------------------------------|
| **Class** | **Pre test** | **Treatment** | **Post test** |
| Experimental (2A = 28) | T₁ | X | T₂ |
| Control (2B = 26) | T₁ | - | T₂ |

Based on Table 2, it can be seen that the research subjects in the experimental class, namely the class that received learning with discovery learning-based instruments and the control class, namely the class that did not use discovery learning-based learning instruments, had the same skills.
2.1. Population
The research subjects were the Second Grade students of SDN Sukorambi 01. The control class consisted of 26 students, and the experimental class consisted of 28 students. The research was carried out in the odd semester of the 2020/2021 academic year. The sampling technique used was purposive sampling. Based on utility consideration, class 2A was decided as an experimental class by implementing Discovery Learning and using discovery learning LKPD, consisting of 14 males and 14 females, while class 2B was decided as a control class by applying discovery learning without using discovery learning based LKPD, consisting of 12 males and 14 females.

2.2. Research Instrument
Research instruments included: test, observation, questionnaire, and interview. The test was used for pre-test and post-test in the form of essay. Observation was made during teaching and learning activities to observe the learning process clearly and accurately. The questionnaire sheet contained statements with closed answers using four categories: Very creative (percentage 87.5% ≤ Cs), creative
(percentage 69.64% ≤ Cs ≤ 87.5%), quite creative (percentage 51.79% ≤ Cs < 69.64%), and less creative (percentage Cs < 51.79%). For activities, there were five categories, namely very active (score 3.5 ≤ Ps ≤ 4), active (score 2.5 ≤ Ps ≤ 3.4), moderately active (score 1.5 ≤ Ps ≤ 2.4), less active (score 1 ≤ Ps ≤ 1.4), and inactive (score 0). Finally, the interview was completed with an open questionnaire for student worksheets.

This study was aimed to be able to easily calculate multiplication using Jarimatika method. The technique used in different calculating in this study was "Jarimatika method with 5 fingers". The technical steps for using jarimatika with 5 fingers were different from jarimatika with 10 fingers [21-24]. The following will be presented respectively:

1) Formula: (KD x 2 Segments) + (MD x 2 Segments) + (TD x 2 Segments) + (LD x 2 Segments)

Example: 4 x 2 = 8

From the figure above, data can be obtained:
1 = front little finger (KD)
2 = front ring finger (MD)
3 = front middle finger (TD)
4 = front index finger (LD)
R = 2, segment = 2

Remember!! Each R (Segment) has value of unit!

Solution:
Formula: (KD x 2 Segments) + (MD x 2 Segments) + (TD x 2 Segments) + (LD x 2 Segments)
= (1X2) + (1X2) + (1X2) + (1X2)
= 2 + 2 + 2 + 2
= 8

So, 4 x 2 = 8

OR
In another way, count the number of down fingers then turn it around to count the second time by sorting the next number.

Formula: KD+MD+TD+LD+LD+TD+MD+KD
= 1+1+1+1+1+1+1+1
= 8

So, 4 x 2 = 8

Remember!! Each finger has value of unit!

2) Formula: (A1 + A2) + (B1 x B2)

Example: 8 x 7 = 56
Figure 3. Multiplication sketch of 8 x 7

From the sketch of Figure 3, the data can be obtained:
A1 = 3 fingers = 30  Remember!! Each letter that has number 1 has value of tens!
A2 = 2 fingers = 20
B1 = 2  Remember!! Each letter that has number 2 has value of unit!
B2 = 3

Solution:
Formula:  \((A1+A2) + (B1 \times B2)\)
\[= (20+30) + (2 \times 3)\]
\[= 50 + 6\]
\[= 56\]
So, 7 x 8 = 56

2.3. Data Collection

Data were collected through pre-test and post-test conducted in the experimental class and control class. Then, the researcher made observation and interview with research subjects. The results of the pre-test and post-test were analyzed quantitatively by using the t-test. While the results of observation and interview were analyzed qualitatively. Quantitative data were analyzed statistically inferential. Qualitative data were analyzed descriptively. The results of inferential statistical analysis were the frequency, mean, and standard deviation. And for different tests, the researcher used an independent sample t-test to test for differences between the experimental class and the control class with a significance level of 0.05. Quantitative analysis was performed statistically by using SPSS 23.

2.4. Hypothesis

The proposed hypothesis in the research was that there was no difference in students' innovative creative skills between the experimental class which was given discovery learning-based learning instruments and the control class which was not given discovery learning-based learning instruments.

3. Result

Preliminary study was conducted by using descriptive qualitative methods, namely testing the validity and reliability of the post-test questions that would be tested on students. The purpose of the validity and reliability test was to determine the accuracy of the measurement instrument in performing its measuring function. The following are the results of the validity and reliability tests carried out on the research subjects. The sample used in the validity and reliability test was 25 students.

| Correlation | b.1 | b.2 | b.3 | b.4 | b.5 | total |
|-------------|-----|-----|-----|-----|-----|-------|
| b.1 Pearson |     |     |     |     |     |       |
| Correlation | 1   | .410* | .409* | .418* | .288 | .603** |
| Sig. (2-tailed) | 25 | .042 | .043 | .038 | .163 | .001 |
| N |       | 25 | 25 | 25 | 25 | 25 |
| b.2 Pearson | .410* | 1 | .380 | .303 | .444* | .742** |
| Correlation | .042 | .061 | .141 | .026 | .000 |
| Sig. (2-tailed) | 25 | 25 | 25 | 25 | 25 |
| N |       | 25 | 25 | 25 | 25 | 25 |
| b.3 Pearson | .409* | .380 | 1 | .246 | .055 | .585** |
| Correlation | .043 | .061 | .237 | .795 | .002 |
The results of testing the validity and reliability of the learning outcomes variable with 10 question items obtained r-count between 0.407 to 0.742 with a significance value (p-value) between 0.000 to 0.001.
0.043 that is smaller than α (0.05) and the r-table value is 0.396, so it can be concluded that all items of learning outcome questions are declared valid. The Cronbach's Alpha coefficient value for the learning outcome variable is 0.770 that is greater than 0.60, so the learning outcome variable instrument is declared reliable.

This study used 54 students as the research subject who were distributed in the experimental class and control class. 28 students were in the experimental class, and 26 students were in the control class. Based on figure 3.1, it can be seen that the experiment resulted in 0 student at the very creative and innovative thinking skill level, 21 students at the innovative creative thinking skill level, 7 at the enough innovative creative thinking skill level, and there were no students at the less creative innovative thinking skill level.

If it seen from Figure 3.2, there are 26 students in the control class. It is found that there are no students at the very creative innovative thinking skills level, 18 students at the innovative creative thinking skills level, 8 students at the enough innovative creative thinking skills level, and no students at the less innovative creative thinking skills level.

This study used the normality test, homogeneity test, and independent test in both classes to obtain statistical data. The result of the data from the homogeneity test obtained a sig value of 0.466. Therefore, it is clear that this result is greater than 0.05; so that, the pre-test results in the control class and the experimental class are homogeneous. For more details, see Table 5 below.

| Test of Homogeneity of Variance | Levene Statistic | df1 | df2 | Sig. |
|---------------------------------|-----------------|-----|-----|------|
| Pre-test Based on Mean          | .540            | 1   | 52  | .466 |
| Based on Median                 | .470            | 1   | 52  | .496 |
| Based on Median and with adjusted df | .470 | 1   | 51.292 | .496 |
| Based on trimmed mean           | .502            | 1   | 52  | .482 |

Case Processing Summary

| Cases |
|-------|

Figure 4. Pre-test result and its relationship to innovative creative thinking skills in the experimental class

Figure 5. Pre-test result and its relationship to innovative creative thinking skills in the control class
Based on the result of homogeneity test, the pre-test score between the Control and Experimental Classes obtained a Levene Statistic (F) value of 0.540 with a significance value of 0.466. The significance value is greater than the α value (0.05). This means that the pre-test data between the two classes (Control and Experiment) have a homogeneous variance, so further tests can be carried out.

After having the homogeneity test, the normality test was then carried out. Based on Table 3.4, it can be seen that the result of the Kolmogorov-Smirnov normality test on the pre-test and post-test scores in the Control Class obtained Z values of 0.531 (Pre-test) and 0.660 (Post-test) respectively with significance values amounted to 0.941 (Pre-test) and 0.776 (Post-test). The two significance values of each test are greater than α (0.05). This means that the two data in the Control Class (Pre-test and Post-test) are spread according to the normal distribution, and the next test can use the parametric test (t test).

**Table 6. Normality test of control class**

|                           | N  | Mean  | Std. Deviation | Minimum | Maximum |
|---------------------------|----|-------|----------------|---------|---------|
| Control Class (Pre-test)  | 26 | 64.73 | 6.103          | 55      | 77      |
| Control Class (Post-test) | 26 | 68.85 | 8.817          | 56      | 92      |

One-Sample Kolmogorov-Smirnov Test

|                           | Control Class (Pre-test) | Control Class (Post-test) |
|---------------------------|--------------------------|----------------------------|
| N                         | 26                       | 26                         |
| Normal Parameters         | a,b                      |                            |
| Mean                      | 64.73                    | 68.85                      |
| Std. Deviation            | 6.103                    | 8.817                      |
| Most Extreme Differences  |                          |                            |
| Absolute                  | .104                     | .130                       |
| Positive                  | .089                     | .130                       |
| Negative                  | -.104                    | -.081                      |
| Kolmogorov-Smirnov Z      | .531                     | .660                       |
| Asymp. Sig. (2-tailed)    | .941                     | .776                       |

a. Test distribution is Normal.
b. Calculated from data.

**Table 7. Normality test of experimental class**

|                           | N  | Mean  | Std. Deviation | Minimum | Maximum |
|---------------------------|----|-------|----------------|---------|---------|
| Experiment Class (Pre-test)| 28 | 65.71 | 6.792          | 50      | 75      |
| Experiment Class (Post-test)| 28 | 79.36 | 6.662          | 61      | 89      |

One-Sample Kolmogorov-Smirnov Test

|                           | Experiment Class (Pre-test) | Experiment Class (Post-test) |
|---------------------------|-----------------------------|------------------------------|
| N                         | 28                          | 28                           |
| Normal Parameters         | a,b                         |                              |
| Mean                      | 65.71                       | 79.36                        |
| Std. Deviation            | 6.792                       | 6.662                        |
| Most Extreme Differences  |                            |                              |
| Absolute                  | .132                        | .157                         |
| Positive                  | .086                        | .098                         |
| Negative                  | -.132                       | -.157                        |
The results of the Kolmogorov-Smirnov normality test on the pre-test and post-test scores in the Experiment Class obtained respectively Z value of 0.697 (Pre-test) and 0.832 (Post-test) with respectively a significance value of 0.716 (Pre-test) and 0.493 (Post-test). The two significance values of each test are greater than \( \alpha \) (0.05). This shows that the two data in the experimental class (pre-test and post-test) are spread according to the normal distribution, and the next test can use the parametric test (t-test).

**Table 8.** Independent t-test of pre-test between control and experimental classes

| Group Statistics | Class | N  | Mean | Std. Deviation | Std. Error Mean |
|------------------|-------|-----|------|----------------|-----------------|
| Pre-test         | Control | 26  | 64.73 | 6.103          | 1.197           |
|                  | Experiment | 28  | 65.71 | 6.792          | 1.284           |

**Independent Samples Test**

| F   | Sig.  | t     | df  | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|-----|-------|-------|-----|----------------|-----------------|-----------------------|----------------------------------------|
|     |       |       |     |                |                 |                       | Lower | Upper |
| Pre-test | .540   | .466  | -558 | 52             | .579             | -.984                 | 1.762 | -4.520 | 2.552 |
|        | -.560  | 51.949| .578 | -.984          | 1.755            | -4.050                | 2.538|

In addition to the normality test, an independent test was also carried out. The results can be seen in Table 8 above. Based on the table, the result of the t-test of independent data, the pre-test score between the control and experimental classes, obtained t-count of -0.558 with a significance value of 0.579. The significance value is greater than the \( \alpha \) value (0.05). This means that there is no difference on average score between the control class and the experimental class before treatment (pre-test), so the assumption that the control class and the experimental class have a homogeneous average is fulfilled.

**Table 9.** Independent t-test of post-test between control and experimental classes

| Group Statistics | Class | N  | Mean | Std. Deviation | Std. Error Mean |
|------------------|-------|-----|------|----------------|-----------------|
| Post-test        | Control | 26  | 68.85 | 8.817          | 1.729           |
|                  | Experiment | 28  | 79.36 | 6.662          | 1.259           |

**Independent Samples Test**

| F   | Sig.  | t     | df  | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|-----|-------|-------|-----|----------------|-----------------|-----------------------|----------------------------------------|
|     |       |       |     |                |                 |                       | Lower | Upper |
|     |       |       |     |                |                 |                       |   |   |
The results of the t-test on independent data of the post-test scores between the control and experimental classes after treatment obtained that the t-count value is -4.965 with a significance value of 0.000. The significance value is smaller than the α value (0.05). This means that there is a difference on average scores between the control and experimental classes after treatment (post-test). The negative sign on the t-value indicates that the average experimental class is higher than the control class.

Furthermore, in this study, a phase portrait was taken which aimed to determine the process of students’ innovative creative thinking skills by completing Jarimatika method with 5 fingers. The subject was selected based on the post-test results, and it was obtained 3 subjects from the experimental class. Then, an interview was conducted with the subject to find out his innovative creative skills in completing Jarimatika method with 5 fingers.

The works of 3 subjects in experimental class who were at very creative innovative level, creative innovative level, and enough innovative creative enough level are depicted in Figure 5, Figure 7, and Figure 9.

The figure above tells about the work of the first subject. The first subject observed the image on the problem, looked for the problem, and solved the problem. Subject 1 collected and managed the data. From the result of managing data, subject 1 could determine the position of the finger he made. After doing this, the subject then labelled the finger point and calculated the position of number. After that, Subject 1 calculated the number of scores according to the problem being worked on. Before making conclusion, subject 1 made corrections first, so there were no mistakes.

After completing work, then an interview was conducted to find out the first subject’s thinking process in completing the work. The following is the result of interview that has been conducted on the first subject.

Researcher : Do you understand the problem that you completed to?
Subject 1  : Yes, absolutely
Researcher : What problem did you accomplish?

Subject 1 understood the problem well and successfully. He was also able to find a solution to the problem. He determined the position of the finger correctly for further calculation. After that, subject 1 also made correction to the answer.
Subject 1: I accomplished the multiplication problem counted by using fingers
Researcher: Then, what did you do for the first?
Subject 1: I tried to observe the picture in the question, then I decided the position of the fingers based on the number in the question appropriately
Researcher: Great, then?
Subject 1: I tried to put the point of the number in the correct finger position then I counted them based on the number of points in the fingers.
Researcher: Did you experience difficulties when you completed the problem?
Subject 1: Yes, I did
Researcher: What kind of problem did you face?
Subject 1: I was bad in memorizing the position of the fingers which are in front and behind. I tried many times to find out the result of multiplication process correctly
Researcher: After you found the answer, did you re-check your answer?
Subject 1: Yes, Mam. I did it in order to remember fast

Based on the analysis on the first subject’s work and interview result, the flow of innovative creative skills can be seen in the following phase.

Figure 7. Phase portrait of subject 1

Figure 7 tells about the work of the second subject. He was able to determine the position of the finger from Jarimatika method that he has drawn. After making observation on the image in the LKPD, subject 2 looked for these questions, then the second subject managed the data by labeling the point on the finger and calculating its position. After finishing working on labeling and calculating, then subject 2 determined the point function and the weight of the finger.

Subject 2 was able to determine finger position from Jarimatika method after understanding the problem. Then, he processed the data by labeling the point on the finger and calculated it. At this stage, he experienced difficulties, and after finishing the work, he did not make correction to the answers.

Figure 8. Work result of subject 2

After completing the work, then an interview was carried out to find out the second subject’s thinking process in completing the work. The following is the results of the interview that has been conducted on the second subject.
Researcher : Do you understand the problem that you completed to?
Subject 2 : Firstly, I observed the picture, and I tried to do it. I was confused which one I had to do. I found the problem finally. I checked the guideline how to accomplish it, and I understood.

Researcher : Then, what problem did you accomplish to?
Subject 2 : I guess, I did the multiplication process by using 5 fingers

Researcher : What did you do for the first time?
Subject 2 : I observed the picture of finger position first, then I decided the position of the finger and I labelled them

Researcher : Then?
Subject 2 : Of course, I found out the answer though it was a bit difficult. That was the reason why I just only drew one picture

Researcher : Did you experience difficulties when you tried to accomplish the problem?
Subject 2 : Yes, I did

Researcher : What kind of problem did you face?
Subject 2 : I experienced difficulty when I decided the finger position and labelled them

Researcher : After you found the answer, did you re-check the answer?
Subject 2 : No, I didn’t. I was already confused

Based on the analysis on the second subject’s work and interview result, the flow of innovative creative skills can be seen in the following phase.

![Figure 9. Phase portrait of subject 2]

The following shows the results of the third subject work after making observation, trying to collect data, being able to manage, and describing one picture of Jarimatika. Then, the subject determined the finger position of the multiplication that has been drawn. After determining the position, the third subject made calculation on the picture.

![Figure 10. Work result of subject 3]

Subject 3 was able to draw Jarimatika of the given problem. However, Subject 3 experienced difficulties in solving the problems given. He experienced difficulties when determining finger position and calculated it. After finishing work, Subject 3 also did not make correction to his answers.
After completing the work, then an interview was carried out to find out the third subject's thinking process in completing the work. The following is the results of the interview that has been conducted on the third subject.

Researcher: Do you understand the problem that you completed to?
Subject 3: I was really confused in completing this problem

Researcher: What problem did you accomplish to?
Subject 3: If I was not wrong, it was about multiplication process by using fingers

Researcher: What did you do for the first time?
Subject 3: What I know is observing the picture and deciding the position of the finger in order to proceed the multiplication process

Researcher: Then?
Subject 3: Of course, I found out the answer though it was a bit difficult. That was the reason why I just only drew one picture

Researcher: Did you experience difficulties when you tried to accomplish the problem?
Subject 3: Yes, I did

Researcher: What kind of problem did you face?
Subject 3: I experienced difficulty when I decided the finger position and turned over the hand

Researcher: After you found the answer, did you re-check the answer?
Subject 3: No, I did not because I was tired and confused

Based on the analysis on the third subject’s work and interview result, the flow of innovative creative skills can be seen in the following phase.

![Phase portrait of subject 3](image)

**Figure 11.** Phase portrait of subject 3

4. Discussion
Researchers can implement this research result into learning through discovery learning method. Students will be directed to higher order thinking, especially creative and innovative thinking. Being creative in this research is related to how students can use the technique of *Jarimatika* well in calculating multiplication [10]. The students’ findings are then analyzed to determine the students’ level of creative and innovative thinking. The results of this study indicate that the research conducted has a significant value on students’ creativity and innovative thinking skills in the experimental class.

The research results showed that the students’ learning outcomes and thinking abilities had increased which is seen from the post-test scores. The scores in the experimental class were significantly better because they were supported by discovery learning-based student worksheets to improve students' creative and innovative thinking skills. The results of this study are also consistent with previous studies [1-2, 12, 17-19]. Thus it can be concluded that the post-test results between the control class and the experimental class have a significant effect after applying discovery learning in the learning instruments that have been developed. This is in line with the results of research conducted by [13-16].

5. Conclusion
Based on the research result and discussion described above, it can be concluded that: first, discovery learning-based learning has a significant effect on students' innovative creative thinking skills in
multiplication by using Jarimatika. This is evidenced by the results of the experimental class is higher than the result of the control class in using discovery learning model. Second, by using discovery learning-based learning, students can be easier to understand the concept of Jarimatika in solving difficult multiplication problems. Actually, this difficulty is occurred because students are less active in activating innovative creative skills towards the problems they face on a daily basis. Therefore, it is suggested to further researchers to use this discovery learning model to improve students’ innovative creative thinking skills.

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