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JURNAL MANAJEMEN PENDIDIKAN ISLAM

HIGH SCHOOL STUDENTS' CREATIVE THINKING ABILITY IN PROPOSING COLLABORATIVE PROBLEMS ON SEQUENCES AND SERIES

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Abstract
This study aims to describe the creative thinking ability of high school students in posing collaborative problems on sequences and series, so the type of research used is a case study with a qualitative approach. The subjects in this study were high school students of grade X who were divided into groups of students with high, medium, and heterogeneous mathematical abilities (high, medium, and low). There are four data collection techniques used in this study, namely the mathematics ability test, the collaborative mathematics problem posing task, observation, and interviews. The instruments in this study are divided into two, namely the main instrument and supporting instruments. The main instrument is the researcher, while the supporting instruments are in the form of the mathematics ability test grid, the collaborative mathematics problem posing task sheet, observation guidelines, and interview guidelines. The collected data were then analyzed into three stages: data condensation, data presentation, and conclusion drawing. Data validity checking in this study uses method triangulation. There are two methods used in checking the validity of the data, namely researcher observation and FGD. The results of the study found that in homogeneous groups, the high homogeneity group demonstrated creative thinking skills in the form of fluency, flexibility, and novelty when posing collaborative problems, while the medium homogeneity group only demonstrated fluency and flexibility. In heterogeneous groups, the researchers found that student groups only demonstrated fluency. The different creative thinking skills of each group were due to differences in the composition of the mathematical abilities of the group members.

Keywords: ability, creative thinking, problem posing, collaborative, sequences and series.

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INTRODUCTION

The current school learning process in Indonesia uses the independent curriculum concept which focuses on increasing the creativity and independence of each student (Kemendikbudristek, 2021). Creativity is a product resulting from creative thinking. Creative thinking is associated with the creative process. In this regard, it is understood that creative thinking activities are important in enhancing student creativity, in line with the objectives of the independent curriculum.

Creative thinking activities in learning can be fostered by honing each student's creative thinking skills. Creative thinking is the mental process an individual uses to discover new ideas or perspectives to solve problems with fluency and flexibility (Siswono & Budayasa, 2006). In the learning process, creative thinking skills are said to be students' efforts to find solutions to problems by developing their own ideas or concepts (Faelasofi, 2017).

Each student's creative thinking ability is classified into three components as explained by Silver (1997) namely fluency, flexibility, and novelty. Fluency refers to the number of questions a person asks when solving a problem. This indicates that the more questions asked, the higher the creativity. Flexibility refers to a person's ability to change approaches when responding to a command, resulting in more than one approach being taken when responding to the command. Novelty refers to the originality of the ideas a person generates when responding to a command.

Low creative thinking skills can lead to low student learning outcomes. This is explained in research Yusnaeni (2017) which states that creative thinking is related to learning outcomes. The higher a student's creative thinking ability, the higher their learning outcomes, and vice versa. Teachers can implement learning that supports students' focused and refined thinking activities to improve creative thinking skills. This aligns with Purwasih (2019) which states that in learning, teachers must involve students' ideas or thoughts in solving problems to improve their creative thinking skills. To improve creative thinking skills, teachers can use learning activities that support this, such as collaborative problem posing (CPP). This statement is based on research Siswono (2005) which states that learning by posing problems can improve three aspects of creative thinking ability (problem information, novelty, and fluency), but flexibility does not increase.

Problem posing is a form of assignment given by teachers to students to formulate questions and solve them using the knowledge they have (Iswara & Sundayana, 2021). Teachers can see the stages of problem submission carried out by students based on their opinions Baumanns & Rott (2022) which consists of the following five stages.

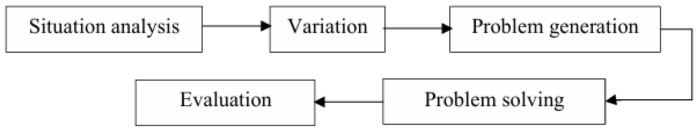

Figure 1. Collaborative Issue Submission Stages

Problem-posing tasks are more effective when done collaboratively with several students. Collaboration facilitates the integration of knowledge derived from interactions between two or more students (Brodie et al., 2010). One of the important points in learning that applies collaborative problem posing is the formation of group members (Moreno et al., 2012). The interaction process between group members and the group's composition significantly determines the effectiveness of group problem-solving.

Specifically, there are two types of grouping methods: homogeneous groups and heterogeneous groups. These groupings take into account three things: estimated student knowledge levels, estimated student communication skills, and estimated student leadership skills (Moreno et al., 2012). Based on the previous explanation, it can be seen that the subjects in this study were divided into two groups, namely homogeneous groups and heterogeneous groups, with reference to the level of students' mathematical abilities. The ideal group division in this study was implemented by applying two principles: inter-homogeneous and intra-heterogeneous. Inter-homogeneous means that diversity between groups must be minimized to ensure that all groups have a similar composition. Composition can be interpreted as the number of concepts that have been accepted or known. Intra-heterogeneous means maximizing diversity within a group (Kirschner et al., 2011).

Collaborative problem-solving can be done based on the results of problem-solving on sequences and series. This statement is based on research results Ardy (2014) namely, problem-posing tasks have a significant influence on the ability to solve problems of arithmetic sequences and series. The quality of questions created in problem-posing tasks has a positive correlation with students' problem-solving abilities, the better the quality of questions created by students, the better their problem-solving abilities. With the correlation between problem-posing tasks and problem-solving abilities, researchers want to know how the correlation of students' collaborative problem-posing tasks is based on the results of problem-solving that has been done previously.

RESEARCH METHOD

This study uses a qualitative approach with a case study as its type of research, so it aims to describe in depth the creative thinking abilities of high school students in homogeneous and heterogeneous mathematical ability groups on collaborative problem-posing tasks of the post-solution posing type on sequences and series. Data collection techniques used in this study are the mathematics ability test, the collaborative mathematics problem-posing task, observation, and interviews. There are two instruments in this study, namely the main instrument and supporting instruments. The main instrument is the researcher himself, while the supporting instruments are in the form of a mathematics ability test grid, a collaborative mathematics problem-posing task sheet, observation guidelines, and interview guidelines.

The subjects in this study were 10th-grade students from the same class, selected using purposive sampling based on the results of the mathematics ability test in that class. The following is the form of collaborative problem-posing assignment used in this study to determine the creative thinking abilities of each subject.

Pay attention to each piece of information provided to answer the questions below!
The sum of the first three terms of a geometric sequence is 119. If the first and second terms remain the same, and the third term is reduced by 17, then the three numbers form an arithmetic sequence. Determine the first term of the geometric sequence!
Challenge:
Create more than one new question that is in accordance with the problem topic above and various strategies for solving the new questions proposed!

Figure 2. Collaborative Mathematics Problem-Submission Task (TPMKM)

The researchers used three research subjects: groups of students with homogeneous high, homogeneous medium, and heterogeneous (high, medium, and low) mathematical abilities. Each group consisted of three students. The criteria for grouping students' mathematical abilities used in this study were adopted from the opinion of Ratumanan & Laurens (2011), namely (1) high mathematical ability with a value range of $80 \leq$ Value≤ 100, (2) moderate mathematical ability with a value range of $60 \leq$ Value<80, and (3) low mathematical ability with a range of $0 \leq$ Value<60. The three groups of students were then given the task of posing collaborative mathematical problems (TPMKM). There were two tasks that had to be completed by each group. In the next stage, the researcher selected the results of one of the tasks to describe how the creative thinking ability of the student group in posing problems collaboratively.

Analysis of research data obtained by researchers was carried out by applying an interactive model Miles, Huberman, dan Saldana (2014) These are data condensation, data display, and conclusion drawing. Data condensation involves sorting the information obtained from the researcher's observations and focus group discussions (FGDs) and focusing it on the research objectives. The presentation of this research data relates to the presentation of the observation and FGD results for each research subject. Conclusions are drawn from a comparison of the researcher's observations and FGD results, thus obtaining a valid measure of each subject's creative thinking ability.

This study uses a triangulation method to verify the validity of the data obtained. Two methods were used: researcher observations and Focus Group Discussion (FGD). Observations were conducted by the researcher during the problem-posing process undertaken by each research subject, including analyzing the problem situation, discussing creative ideas for developing new questions, and determining various methods for solving the newly developed questions. The FGD was conducted by the researcher after the research subjects completed the TPMKM. The purpose of the FGD was to understand the group's thinking in completing the TPMKM. Therefore, the FGD also validated the observations made by the researcher, allowing the researcher to obtain valid conclusions regarding the creative thinking abilities of each subject.

The observations conducted by the researchers and the FGDs were based on creativity indicators and stages of collaborative problem-posing. The following are the creativity indicators used in this study.

Table 1. Components of Creativity in Problem Filing

No.	Creativity Components	Creativity Component Indicators	Code
1.	Fluency	Students can produce more than one varied question.	FC
2.	Flexibility	Students can submit questions that have more than one solution.	FL
3.	Novelty	Students can ask questions that have different content and context from the given problem.	NV

Fluency in generating more than one varied problem in research can be in the form of mathematical problem posing and contextual problems. Flexibility in this research means that students can submit problems using more than one solution method, so that the proposed problems have various solution methods. The novelty component in the form of content in this research is like changing the flow of information on the problem given, while the novelty of the context is like changing the type of mathematical problem text into a contextual problem. Novelty can be fulfilled when the problem proposals compiled by students have novelty in content and context, so that if only showing one of them is considered the student does not have novelty in the proposed problem.

RESEARCH RESULTS AND DISCUSSION

A. High Creative Thinking Ability of Homogeneous Groups

Highly homogeneous groups can demonstrate creative thinking skills in the components of fluency, flexibility, and novelty in solving problem-posing tasks. This is the same as research Wahyuni & Sutiarso (2024) which also states that students with mathematical creative thinking skills at level 4 (very creative) can demonstrate fluency, flexibility, and novelty. Other research by Widyastuti & Harun (2021) also found that students with high thinking skills at level 4 (very creative) met the indicators of fluency, originality, flexibility, and elaboration in problem posing learning with an open-ended approach based on story problems.

Fluency is seen in the differences in the variations of the two problems proposed by the highly homogeneous group. These differences in variation include geometric and arithmetic sequences, the flow of problem information, the type of problem text, and the questions asked. Each member of the highly homogeneous group expressed creative ideas in proposing these varied new problems. This is seen during the discussion carried out by the highly homogeneous group collaboratively and evenly, so it can be said that the group did not rely on just one member in finding and realizing creative ideas in compiling new problems. Fluency in the highly homogeneous group can be seen in the submission of the following two new problems.

FC

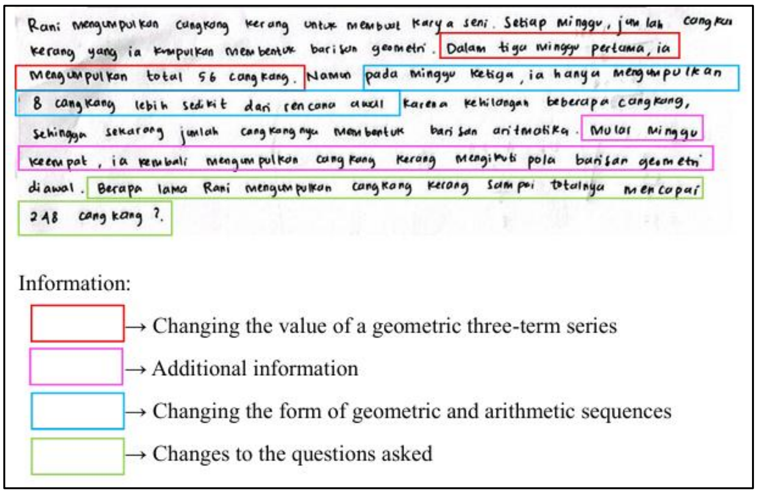

Figure 3. First Question Submission for Highly Homogeneous Group

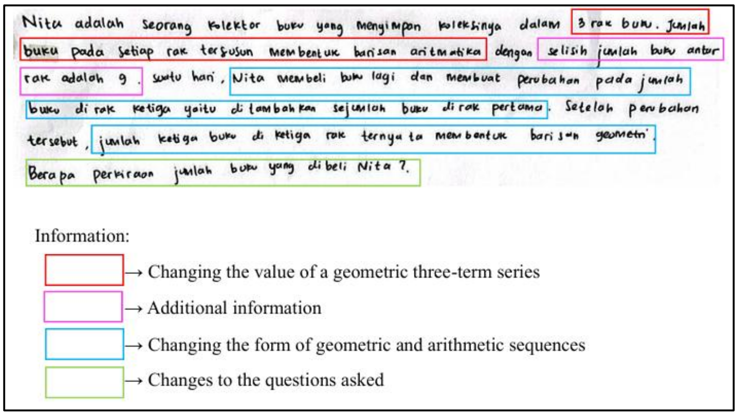

Figure 4. Submission of Questions for the Two Highly Homogeneous Groups

Flexibility can be demonstrated by the high homogeneity group during the FGD by explaining methods other than those written in the solution of the first and second question submissions. The explanation of the method cannot be proven to be accurate in answering the questions asked in each question submission. This is because the high homogeneity group only explains it verbally without demonstrating the application of the method in writing to answer the questions asked. The flexibility explained by the high homogeneity group is related to two different methods for determining the value of the quadratic equation, namely the factoring method and the abc formula. The high homogeneity group also uses different methods in the elaboration of a series of three geometric terms, namely in algebraic form and using the formula for the nth term of a geometric sequence. The flexibility demonstrated by the high homogeneity group can be seen in the following interview transcript.

Label	Interview Transcript	Code
PHT1FL79	In the results of the first assignment, is there another way you can solve the problem?	FL
SHT1FL80	Yes, we can describe a three-term geometric sequence by adding the form of the first term to the third term. We can also use the factoring method to determine the value of the first term in a quadratic equation.	
PHT2FL83	In the second assignment, are there any other ways you can use to solve the problem?	

SHT2FL84	We believe there's no other way to solve the second problem. Using the factoring method to determine the first term, we can convert it to the root method. This is our reason for saying there's no other way to solve the second problem, as it doesn't alter the majority of the solutions already implemented.	

The fluency and flexibility demonstrated by homogeneous groups were high in collaborative problem posing according to research Puspitasari et al. (2021) which says that high homogeneity groups can be creative and innovative in creating problems and solving them.

The novelty of content and context (NV code) can be demonstrated by the highly homogeneous group only in the second question submission. In the second question submission, the novelty of content is seen from the difference in the flow of information between the problem and the given question. The flow of information in the given question relates to the value of the series of the first three terms of a geometric sequence, which is then used to construct the first three terms of an arithmetic sequence. In the second question submission, the highly homogeneous group uses the flow of information related to the value of the series of the first three terms of an arithmetic sequence, which is then used to construct the first three terms of a geometric sequence. The novelty of context is seen in the transformation of the mathematical problem into a contextual problem, namely related to the number of books on the shelf. In the first question submission, the highly homogeneous group only shows context novelty, like the second question submission. The problem context used in the first question submission is based on the experience of one member of the highly homogeneous group in school activities. The flow of information used in the first question submission is the same as the given question, so the novelty of content cannot be demonstrated by the highly homogeneous group. The creative thinking ability in the form of novelty carried out by the highly homogeneous group in the second question submission is the same as the research results Widyastuti & Harun (2021) which says that groups of high-ability students can create new problems that have never been exemplified.

Highly homogeneous groups can collaboratively propose both questions to determine ideas for change. These ideas for change are based on the thoughts of each member of the highly homogeneous group. Each member of the highly homogeneous group can respond to and add to the ideas expressed by other members, thus creating new questions with more variety and novelty. This collaboration in highly homogeneous groups is consistent with research Nisa' et al. (2023) who stated that collaborative problem-posing works well in groups of students with high mathematical abilities. The differences in mathematical understanding between these groups are not too great, allowing them to share ideas without relying on one another.

B. Creative Thinking Ability of Homogeneous Groups

The homogeneous group demonstrated creative thinking skills only in the fluency and flexibility components. This is similar to research conducted by Wahyuni & Ratu (2018) which says that students with average abilities can only achieve fluency and flexibility. Another study by Isna et al. (2018) also stated that students with average abilities can meet the creative thinking indicators of fluency and flexibility. Students with average abilities cannot achieve novelty because it is difficult to find innovative changes that have never been encountered before. (Yayuk et al., 2020).

Fluency was demonstrated by the moderately homogeneous group by proposing two new, varied problems. This variation was seen in the differences in geometric sequences, arithmetic sequences, the questions asked, and the types of problem texts. Each member of the homogeneous group was expressing creative ideas for changes that could be made to the two new problems, but only one member was able to realize the idea in compiling the new problem. This was shown in the results of the researcher's observations when observing the discussion carried out by the highly homogeneous group. In the discussion, it was seen that the moderately homogeneous group trusted only one member to realize the idea that had been agreed upon together to compile the new problem, but still agreed on the results of the realization of the idea together. Fluency in the moderately homogeneous group was the same as the research conducted by Puspitasari et al. (2021) which states that student groups can be innovative in creating new questions. The fluency of the homogeneous group can be seen in the submission of the following two new questions.

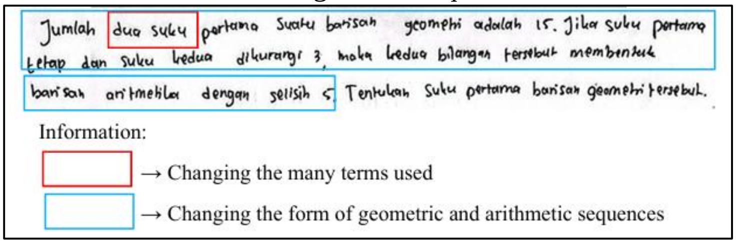

Figure 5. First Question Submission for the Medium Homogeneous Group

FC

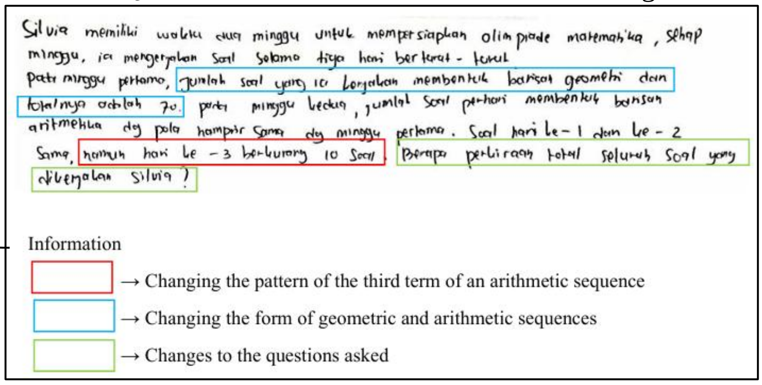

Figure 6. Submission of Questions for the Two Medium Homogeneous Groups

The moderate homogeneous group demonstrated flexibility in solving the second problem by producing two different solution methods. These different solution methods were demonstrated by the moderate homogeneous group during the FGD interview. The moderate homogeneous group explained two methods that can be used to determine the roots of a quadratic equation: the factoring method and the abc formula. On the TPMKM results sheet, the moderate homogeneous group only wrote the abc formula method, while the factoring method was written in the FGD interview. The following is evidence of the flexibility demonstrated by the moderate homogeneous group during the FGD.

FL

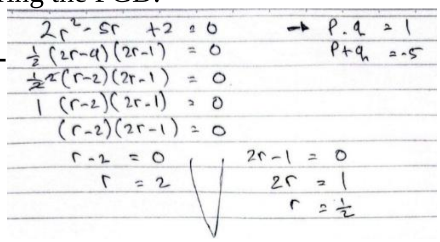

Figure 7. Flexibility of Medium Homogeneous Groups in the Second Question Submission

The accuracy of both methods in answering the questions posed in the second questionnaire can be determined, as evidence is provided. The flexibility demonstrated by the moderately homogeneous group is similar to the research findings Fadhlurrahma et al. (2023) that students with average abilities include students who can produce various alternative answers correctly

In the first problem, the moderately homogeneous group could only explain and write one solution method, namely the factoring method. This is because the moderately homogeneous group used the same solution steps as the problem given. Observations show that the moderately homogeneous group only stuck to the problem's solution steps, so they were unable to produce different steps. The variety of solution methods that the moderately homogeneous group could not produce in the first problem showed a lack of flexibility. The flexibility demonstrated by the moderately homogeneous group can be seen in the following interview transcript.

Label	Interview Transcript	Code
PHS1FL71	In the results of the first assignment, is there another way you can solve the problem?	
SHS1FL72	We believe there's no other solution to the second problem. This is because many of the terms used in the second problem are different from those in the first problem, and therefore the solution steps are also different. The quadratic equation involving ratios is also not generated in the second problem, so there's no alternative method as in the first problem.	
PHS2FL75	In the second assignment, are there any other ways you can use to solve the problem?	FL
SHS2FL76	In determining the ratio value in the form of a quadratic equation, we can use another method in the form of the factoring method.	

The novelty (NV code) of content and context could not be demonstrated by the moderately homogeneous group in both questions that had been prepared. Both questions did not show novelty of content. This is because both questions use the same information flow as the given problem, namely the known geometric sequence series and used to construct an arithmetic sequence. Context novelty can only be demonstrated by the moderately homogeneous group in the second question proposal by changing the mathematical problem into a contextual problem, while the first question proposal uses the same context as the given problem, so there is no context novelty in the first question proposal. The creative thinking component in the form of novelty that is not demonstrated by the moderately homogeneous group has the same results in the research findings Hery (2016) which says that the group is able to discuss and determine strategies in presenting problems, but cannot develop these ideas or strategies in an original way.

The medium homogeneous group collaboratively determined the change ideas for both question proposals. This was evident from the active participation of each member of the medium homogeneous group in explaining the change ideas and experimenting with the ideas they proposed. Only one member of the medium homogeneous group successfully experimented with the ideas, so the trial of the change ideas for both question proposals was entrusted to that one member. The decision to use the tested ideas in developing new questions was still based on the opinion of each member of the medium homogeneous group. The medium homogeneous group was able to capitalize on the strengths of each group member without compromising their confidence in their own abilities, thus avoiding relying on a single member to make all the decisions needed to complete the task.

C. Creative Thinking Ability of Heterogeneous Groups

The heterogeneous group only demonstrated creative thinking skills in the fluency component. The reason that only fluency alone fulfills creative thinking skills in heterogeneous groups can also be based on research results Khumaidi & Budiarto (2013) which says that students with high and medium abilities can demonstrate fluency, while students with low abilities cannot but demonstrate all indicators of creative thinking, so that the collaboration of the three students with different initial abilities is less than optimal in demonstrating all indicators of creative thinking.

Fluency can be demonstrated by heterogeneous groups by submitting two varied problems. These variations include differences in geometric sequences, arithmetic sequences, the third term pattern of arithmetic sequences, and the type of problem text. Each member of the heterogeneous group was seen actively contributing ideas and experimenting with those ideas, but only one member succeeded in experimenting with the idea. The success of the experiment carried out by one member was then used in both problem submissions. During the discussion, it was apparent that the heterogeneous group only relied on the thinking of one member because the other members felt incapable of realizing the idea. Fluency in the heterogeneous group can be seen in the submission of the following two new problems.

KF

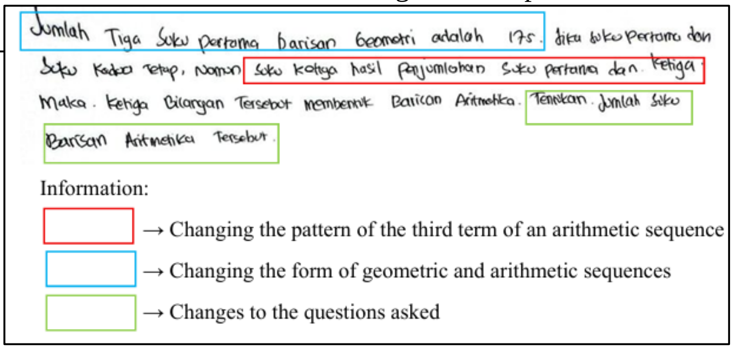

Figure 8. Submission of the First Question for the Heterogeneous Group

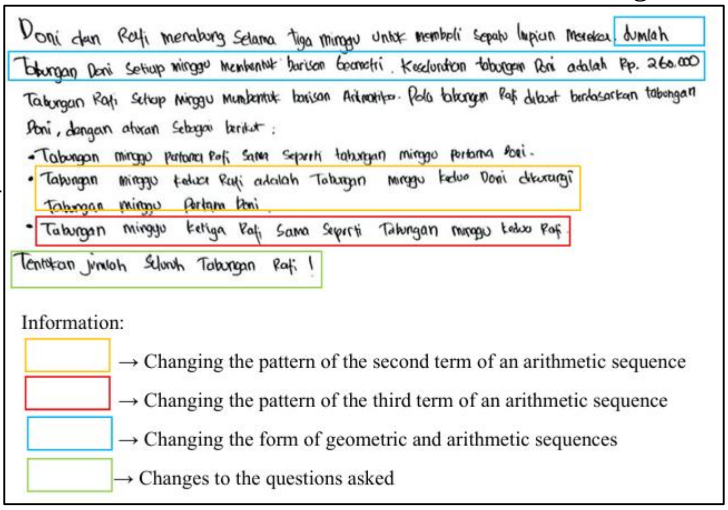

Figure 9. Submission of Questions by the Two Heterogeneous Groups

The heterogeneous group failed to demonstrate flexibility in both of the questions they had prepared. This was because the problem information flow used in both questions was the same, so the heterogeneous group used the same steps in both questions. The similarity of the steps in both questions increased the heterogeneous group's confidence that there was no other appropriate method to use to answer the questions posed other than the method they had written. The heterogeneous group's explanation regarding the lack of flexibility in the TPMKM can be seen in the following interview transcript.

Label	Interview Transcript
PHE1FL67	In the results of the first problem-solving assignment, are there any other ways you can solve the problem?
SHE1FL68	We don't think there is one, because the solution we've written is the only way to solve the first problem. A different solution, in our opinion, would involve first converting the three-term arithmetic sequence into a series before substituting the first term and the ratio to answer the question.
PHE2FL69	In the second problem-posing task, are there any other ways you can use to solve the problem?
SHE2FL70	In our opinion, there is none, because in the second problem statement, the arithmetic sequence arrangement pattern is only changed, so the stages of solution are the same as the problem given and the first problem statement.

The heterogeneous group could not demonstrate novelty in content and context in both problem proposals. The information flow used in both problem proposals was the same as the given problem, namely knowing the geometric sequence and using it to construct an arithmetic sequence. The similarity in the information flow indicates the absence of novelty in content in both problem proposals. Context novelty could only be demonstrated by the heterogeneous group in the second problem proposal by changing the mathematical problem into a contextual problem. In the first problem proposal, the heterogeneous group used the same type of problem as the given problem, namely a mathematical problem, thus not demonstrating any context novelty.

Heterogeneous groups demonstrated both good and poor collaboration when completing problem-posing tasks. Good collaboration was demonstrated by heterogeneous groups when each member attempted to construct new arithmetic and geometric sequences, as well as formulating a second problem based on the agreed-upon change idea into a contextual problem related to saving activities. Poor collaboration was seen when heterogeneous groups realized ideas and made decisions based on the opinion of only one member, namely a student with high mathematical ability. This was caused by a decrease in the self-confidence of students with medium and low mathematical ability when they were unable to realize ideas into the formulation of new problemsThis heterogeneous group collaboration is similar to the results of research from Khusnah & Rosyidi (2024) which states that active collaboration is only carried out by students with high and medium abilities, while students with low abilities are less visible in the process.

CONCLUSION

Based on the research results and discussions that have been described in the previous chapters, the following conclusions can be drawn regarding the creative thinking abilities of high school students in posing collaborative problems on sequences and series.

A. Creative Thinking Ability of Homogeneous Groups in Collaborative Problem-Submitting Tasks

Highly homogeneous groups demonstrate creative thinking skills in the form of fluency, flexibility, and novelty. Each member of a highly homogeneous group plays a role in generating ideas for change and deciding on their implementation. This demonstrates strong collaboration within highly homogeneous groups, as they are not dependent on a single member. Moderately homogeneous groups demonstrate creative thinking skills in the form of fluency and flexibility alone. This is due to the less than optimal collaboration of moderately homogeneous groups. Each member of a moderately homogeneous group can express ideas for change, but the implementation of these ideas is based solely on the thinking of one member.

B. Creative Thinking Ability of Heterogeneous Groups in Collaborative Problem-Submitting Tasks

Heterogeneous groups demonstrate creative thinking skills in the form of fluency alone. This is because heterogeneous groups rely solely on one member to implement ideas for change and decide which ideas to use in problem-solving. This dependency stems from students with moderate and low mathematical abilities lacking confidence in their abilities and relying solely on students with high mathematical abilities.

SUGGESTIONS/RECOMMENDATIONS

Based on the conclusions of the research results, the suggestions that researchers can put forward are as follows.

1. This study found that highly homogeneous groups demonstrated greater creative thinking skills in the form of fluency, flexibility, and novelty compared to moderately homogeneous and heterogeneous groups. These findings can be considered by teachers in implementing group-based learning models to enhance the creativity of each student, thus creating a creative product that demonstrates fluency, flexibility, and novelty for the entire group.
2. Researchers interested in conducting similar research are advised to consider group composition to achieve their desired research objectives. Further research could consider heterogeneous groups, beyond those comprising high-, medium-, and low-ability students, to provide a deeper understanding of the creative thinking abilities of heterogeneous groups when posing problems collaboratively.

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