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The Effectiveness of Star Strategy Learning on Gifted Students' Mathematical Creative Thinking Ability

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Abstract: The purpose of this research is to investigate the mathematics creative thinking skills of gifted students in the International Private School before, during, and after receiving instruction using the STAR method. An analysis of behaviour analysis (ABA) was used as the study approach for the exploration of a certain subject. The sample of the study was selected from International private school in Al-Ain, UAE during the academic year 2020-2021. The investigation focused on two pupils who were both considered to have impressive levels of academic ability. An exercise in description was used as a component of the investigation. According to the findings of this research, subject G1 exhibited a higher ability for mathematically innovative thinking than subject G2 did in baseline condition 2 (A2), with subject G1 attaining 93.33 percent and subject G2 achieving 90 percent. Throughout the whole of this experiment, this was consistently the case for both of the individuals. Subject G1 had a higher percentage of creative thinking ability than subject G2 (83.3% vs. 81.5%), despite the fact that in baseline condition 1 (A1), both individuals' creative thinking abilities were at their lowest possible level. Subject G1 had a score of 88.75% in the intervention condition, whereas subject G2 had a score of 86.25% in the intervention condition. This research came to the conclusion that the use of the STAR learning technique, which consists of the phases Search, Translate, Answer, and Review, is beneficial on mathematical creative thinking abilities as measured by Problem Sensitivity, Fluency, Flexibility, Originality, and elaboration.

Keywords: Star Strategy, Creative Thinking, Gifted Students.

1 Introduction

The process of studying mathematics may be used to cultivate creative thinking or creative thinking skills [1]. Mathematics can be thought of as a way of thinking or a method of reasoning, as a symbolic language that can be understood by all cultured nations, as a form of art, such as music that is full of symmetry, patterns, and rhythms that can entertain, as well as a set of tools for people who make maps, construct buildings, navigate the cosmos, and build machines, as well as for accountants [2]. A person's mental capabilities may be improved by the study of mathematics. Students need to be presented with challenges that may be solved in a variety of ways in order to develop their creative thinking abilities. Students are able to supply ideas or replies that vary according to their own unique thoughts and capabilities when they have access to a variety of possible responses [3].

There are a number of intriguing student personalities to investigate, all of whom are connected to imaginative contemplation in some way. One of them focuses on very talented kids. Because creativity is the most significant component and more often emerges in talented persons, talent that exists in pupils cannot be separated from the feature of creativity because creativity is the most important component [4]. Some really talented pupils are able to tackle issues in a manner that is distinct from the approach used by other students. The innovative approaches to problem-solving that talented kids bring to the table may surface at any time, which paves the way for the development of one-of-a-kind solutions that can be used to circumvent challenges in the future. Krutetskii argues that talented kids are able to perceive the world through a mathematical lens, which enables these students to make rapid generalizations to areas of mathematics that are more comprehensive in terms of connections, operations, and the fluidity of a mental process [5].

There are not many activities that demand students to engage in divergent thinking throughout the learning process that is carried out by pupils. In contrast, creativity is engaged in via divergent thinking. Taking into account the low number of students participating in abstract and non-traditional forms of education. Therefore, teaching kids how to solve problems by doing them themselves is one strategy that may help them succeed in mathematics [6]. It is assumed that students will have an easier time comprehending the problems presented, as they are based on a variety of situations that

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are directly relevant to the students' day-to-day lives. As a result, students will have an easier time finding solutions to the concepts that have been learned. The STAR Strategy is one alternate approach to the solution of problems that may be used [7].

Maccini and Ruhl ([8] suggest that the ones who originally came up with the idea for the STAR (Search, Translate, Answer, and Review) method, which is based on the problem-solving phases proposed by Polya via the use of mnemonic techniques (making abbreviations). The mnemonic for the keyword consists of two phases, one of which is vocal and the other of which is visual. The term STAR is used as an acronym for the actions that need to be taken in order to solve the issue while using this mnemonic approach.

STAR is a problem-solving method; therefore, it makes it easier for students to go through the steps that need to be taken in order to discover solutions to the challenges they are now facing. STAR is a strategy that may be used to improve students' ability to think creatively and mathematically while solving issues. This strategy makes use of mnemonics. with the purpose of ensuring that pupils will no longer have substantial difficulty when confronted with challenges that need abilities in problem-solving. Therefore, taking into consideration the points of view of exceptionally talented pupils in mathematically innovative thinking is an essential component that can no longer be ignored. One receives a great deal of advantages, all of which are bound to have a favourable influence on individuals who are engaged in the field of education [9].

2 Methods

The investigation was carried out using a technique known as Single Subject Research. The A-B-A reversal design was used for the sake of this particular investigation. One of the enhancements that were made to the fundamental A-B design was the A-B-A design [10]. The fundamental process is not very dissimilar to the A-B design; the only significant difference is that the baseline circumstances have been replicated. Following the completion of the continuous monitoring of the target behaviour under the baseline condition (A1) for a predetermined amount of time, the subsequent monitoring of the behaviour was carried out under the intervention condition (B). In addition to that, measurements were taken under the second baseline condition (A2). The purpose of including the second baseline condition (A2) is to serve as a control for the intervention condition. This will enable it to be determined whether or not there is a causal connection between the independent variable and the dependent variable [11].

The sample of the study was selected from International private school in Al-Ayen, UAE during the academic year 2020-2021.

The score of the mathematics creative thinking capacity of talented children was utilized as the data for this investigation. The data was collected via online donations made before, during, and after the STAR Strategy Learning was administered to the pupils [12]. The mathematical creative thinking ability test that comes before that is referred to as Baseline 1 (A1), the creative thinking ability test that comes after that is known as Baseline 2 (B), and the mathematical creative thinking ability test that comes before that and as long as the Student Worksheet is provided in STAR learning is known as intervention (B) (A2) (Puccio et al., 2020).

3 Results and Discussion

Baseline 1

The first step in the data gathering process is referred to as Baseline 1 (A1). This criterion will be fulfilled over the course of three sessions, each of which will last for a maximum of one hour. During each session of the Baseline 1 (A1) conditions, the distribution of question instrument sheets and response sheets is carried out online using the WhatsApp application. Students are given five questions to answer during each session that are based on their ability to think creatively about mathematics. These questions contain indications of sensitivity (Problem Sensitivity), fluency (Fluency), flexibility (Flexibility), novelty (Originality), and detailing (elaborating) [13]. Rows and series make up the instrument material that is provided under the Baseline 1 (A1) circumstances. The conditions of Baseline 1 (A1) were carried out via the internet using the Google Meet or Zoom program, and the researchers oversaw their progress. The proportion of children with gifted thinking abilities who fall into the gifted 1 (G1) and gifted 2 (G2) categories as compared to those who fall into the baseline 1 (A1) category.

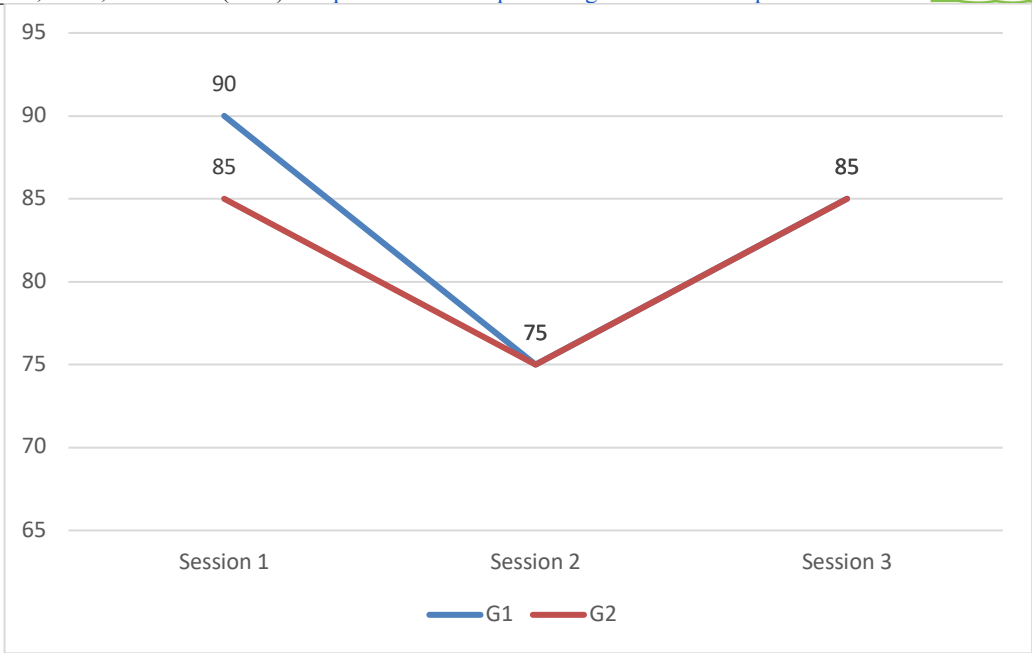

Fig. 1. Creative Thinking Ability of G1 & G2 in Baseline 1

The findings of the mathematical creative thinking ability test administered at baseline condition 1 (A1) reveal that the individuals G1 and G2 achieved an average score percentage of 83.3% and 81.6%, respectively, throughout this phase of the study. According to the categorization of descriptive analysis interpretation that is provided in table 3.3, a subject is considered to have a good score if their average percentage score falls within the G1 or G2 range. Subject G1 spends an average of 53 minutes working on the mathematical creative thinking ability instrument, whereas subject G2 spends an average of 55 minutes working on the same test.

Before being instructed in the STAR method, the findings of the observations made on subject G1 were gathered. Subject G1 showed signs of having a strong grasp on the fundamentals of the offered series and series questions. This research allows G1 topics to finish, and one of the requirements is the capacity for creative thought. In this particular instance, the G1 subject seems to be used to working on math contest issues, and as a consequence, the answer and the findings are pretty good for the researchers. This is due to the fact that the G1 subject may already have innovative ways of thinking. However, topic G1 is still limited in the flexible component of the creative thinking indication since it only provides one response to the issue, although it is anticipated that subject G1 would provide more than one answer to the question. When it comes to gathering subjects, Group G1 is always on time and stays ahead of Group G2 throughout the whole process.

The findings of the observations made on G2 patients before the STAR method was implemented. Subject G2 is not all that dissimilar to the previous subject, G1. Subject G2 seemed to grasp the overall idea of the series and series questions that were presented to them. Subject G2 was also seen to have been taught to work on math contest problems; the responses provided by Subject G2 are transparent and provide researchers with a level of satisfaction that is sufficiently enough. The G2 topic has the same issue with flexible indications that the G1 subject does, hence this is both of their areas of weakness. During the zooming process, subject G2 seems to be less active than subject G1, and when the data are gathered, subject G2 is always lengthier than subject G1.

Intervention Condition

Overall, based on the data shown in the table above, there was an increase in the score of mathematical creative thinking abilities in subjects G1 and G2 who were exposed to the intervention, in comparison to baseline 1. However, the rise was not significantly different from baseline 1. Subjects G1 and G2 both have an average percentage score that is 88.75% higher than subject G2's score of 86.25%. The average percentage score for topics in grades G1 and G2 is pretty satisfactory. In the condition where there was an intervention, subject G1 spent an average of 48 minutes working on the mathematical creative thinking ability instrument, whereas subject G2 spent an average of 50 minutes working on the instrument.

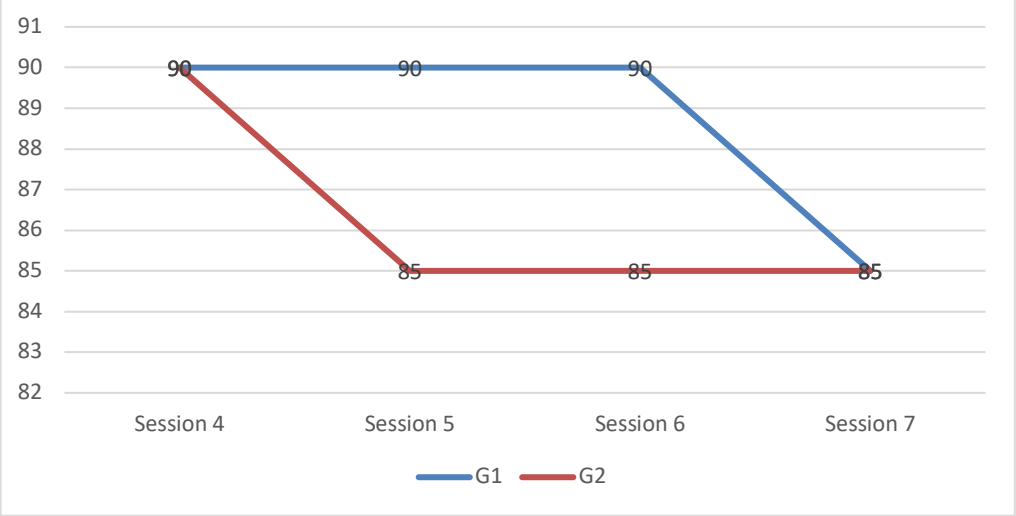

Fig. 2. Creative Thinking Ability in Intervention Condition

After acquiring steady data at the baseline condition 1, the intervention consisted of teaching both of the participants the STAR Strategy (A1). First, subjects G1 and G2 in the intervention condition completed the students' working sheet that was based on the STAR technique. Afterwards, they worked on the mathematics creative thinking ability test. In the process of putting into action this online study, the time allotted to work on the students' working sheet during each session is sixty minutes, and the data is immediately gathered by emailing it to whatsapp. The next day, subjects G1 and G2 worked on the mathematics creative thinking instrument problems that they had completed on the previous day.

According to the findings of the observation of the G1 subject in the intervention condition, the subject's score improved. Subject G1 seems to have been able to work on the sensitivity instrument (problem sensitivity) by either identifying the issue or disregarding the facts that are not appropriate to address the problem. Both of these strategies appear to have been successful. Subject G1 has also been successful in working on fluency difficulties by attempting more than one method of addressing problems and working on them in the proper and correct manner. The same may be said for the indication of originality as well as the elaborating indicator. The G1 subject is able to provide answers to questions that are categorized as open questions, which contributes to the flexibility indicator; but, in order to fulfil the flexibility indicator, which needs the subject to provide more than one response, each answer contributes less. The G1 topic is nevertheless considered to be within the "less category" umbrella in order to accommodate the flexibility indication. Concerning the manner in which one conducts oneself, subject G1 never arrives late for the study and remains engaged throughout its whole. Subject G1 spent a shorter amount of time in this condition compared to condition 1, the baseline (A1).

According to the findings of the observation of G2 patients who were placed in the intervention condition, their scores likewise increased. It would seem that Subject G2 is capable of working on the issue sensitivity indicators by identifying established difficulties. G2 pupils may also work on questions with fluency indicators by finding many solutions to a problem and ensuring that all of their answers are right. Subjects at the G2 level are also able to develop and solve issues including originality indicators. Subject G2 and Subject G1 are not very different from one another in terms of the flexibility indicator. Subject G2 has been successful in solving problems that are categorized as open questions; however, in order to fulfil the flexibility indicator, which requires the subject to answer more than one answer, subject G2 is still lacking because it only includes a single answer, and therefore, in order to meet the flexibility indicator, it is still quite lacking. Regarding the mentality component of the topic, G2 never misses an opportunity to join the zoom and remains engaged throughout the study at all times. When it comes to collecting responses, subject G2 is usually given more time than subject G1, despite the fact that the time gap between the two is not very different [14].

Baseline 2

In this one-subject study that follows the A-B-A design format, the final condition is referred to as Baseline 2 (A2). The technique that was employed for the baseline condition 2 was the same one that was used for the baseline condition 1, and it consisted of three sessions. In the second baseline condition, students spent each session working on five problems that were indicative of their ability to think mathematically. These questions focused on issue sensitivity, fluency, flexibility, and originality, and they were expounded on for a maximum of sixty minutes [15]. The content of sequences and series that was presented over these three sessions served as the basis for the mathematical creative thinking ability instrument that was administered.

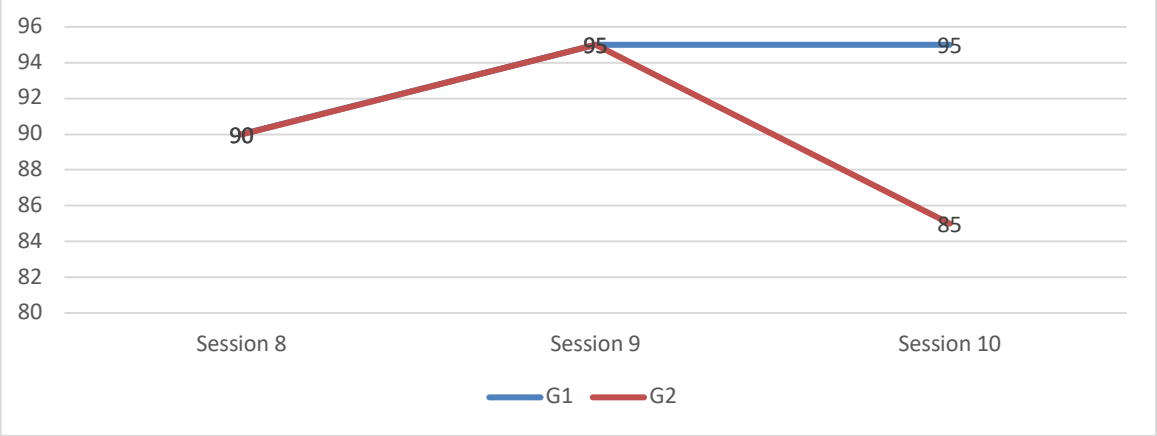

Fig. 3. Mathematical Creative Thinking Ability in Baseline 2

Even though there is not much of a difference between baseline 1 (A1) and the intervention conditions, the percentage score of mathematical creative thinking ability has grown in baseline condition 2 (A2) even if it is not significantly different from baseline 1 (A1). The subjects G1 and G2 both have an average percentage score of 90, whereas subjects G1's score is 93.33%. Subject G1 spent an average of 45 minutes working on the mathematical creative thinking ability instrument during baseline condition 2 (A2), while subject G2 spent an average of 47 minutes working on the same task.

The findings of the observations made on topic G1 under this circumstance, after the worksheet using the STAR approach was given to the student, did not significantly vary from those made before the worksheet was given to the student. Subjects in G1 are able to identify or recognize what is known in an issue on a regular basis. G1 participants also have the capability of finding more than one solution to an issue. Subjects at the G1 level are able to solve issues in their own unique style and are able to exactly and clearly outline a problem. In baseline condition 2 (A2), it is also found that they are able to supply more than one response to the challenge. Subject G1's behaviour and attitude did not change between baseline 1 and intervention conditions. Subject G1 was always on time when joining to zoom and on time when collecting answers, and he was always active while the study was being carried out. This indicates that subject G1 did not benefit from the intervention.

The findings of the observations made on individuals G2 at baseline condition 2 (A2) are comparable to those made on subjects G1, suggesting that there is little difference between the two groups. Subject G2 is still able to recognize what is known about an issue and is able to overlook information that are not required in order to solve problems. Additionally, subject G2 is able to solve difficulties in more than one method. Subjects G2 are also capable of solving issues in their own unique manner and are able to provide sufficient information in their replies to ensure that the solutions provided are crystal clear and straightforward for the researchers to comprehend. During the course of the study, subject G2 demonstrated an engaged attitude toward the research.

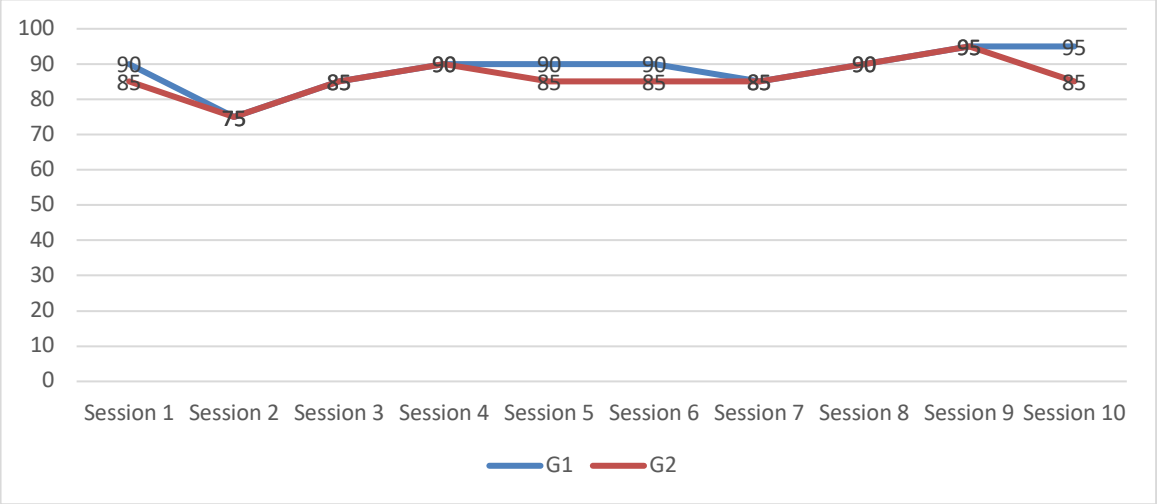

Fig. 4. Overall comparison of creative thinking ability

It is abundantly obvious that individuals G1 and G2 have the greatest average in terms of their mathematics creative

thinking abilities at the baseline condition 2. (A2). The subjects G1 and G2's average mathematical creative thinking ability was higher in the intervention condition compared to the baseline condition 1 (A1) and lower compared to the baseline condition (A2); however, the difference in values between conditions was not significantly different from one another. Both subject G1 and subject G2 have a processing time that is, on average, 49 minutes longer than subject G2.

Table 1: Stability Trend

Subject	Baseline 1	Intervention	Baseline 2
G1	100% (stable)	100% (stable)	100% (stable)
G2	100% (stable)	100% (stable)	100% (stable)

A consistent starting point 1 condition indicates that the intervention may now be administered without further delay. The intervention was terminated after it was determined that the condition being treated by the intervention was stable. After that, conditions from baseline were repeated through baseline 2 (A2) for a total of three sessions.

Table 2: Change on Subject Level

Subject	Baseline 1	Intervention	Baseline 2
G1	90-85 % (-5%)	90-85 % (-5%)	90-95 % (+5%)
G2	85-85 % (0%)	90-85 % (-5%)	90-85 % (-5%)

The difference between the initial data and the most recent data represents the amount of change in the data associated with a condition. Calculating the difference between two sets of data is the first step in identifying changes in level. Once this has been done, one may decide whether the data are moving upwards (+), horizontally (=), or downwards (-).

In this particular investigation, an explanation was developed that was predicated on the viewpoints held by Gast and Ledford. This was done so as to provide credence to the findings of the analysis that differentiated between and between the situations. When using the Single Subject Research approach, the difference between the two conditions that are being compared side by side may be used to determine how successful an intervention was [16]. If there is a difference between the baseline conditions and the conditions after the intervention, then we may say that the intervention was successful.

Overall, gifted 1 subject in baseline 1 (A1) received an average score of 83.3% in the good grade category. Following this, gifted 1 subject in the intervention condition (B) received an average score of 88.75% in the good grade category. Finally, gifted 1 subject in baseline condition 2 (A2) received an average value of 93.33% in the very good category. This demonstrates that a person with an IQ score of 122 has extremely high standards for the quality of their work, which results in consistency within the value area. Because there is a difference between the baseline condition and the intervention, it is believed that teaching Gifted 1 students the STAR technique for mathematics creative thinking abilities is beneficial. This is due to the fact that there is a difference between the two.

In the end, gifted 2 subjects who participated in the baseline condition 1 (A1) obtained an average score of 81.6% in the good category. On the other hand, gifted 2 subjects who participated in the intervention condition (B) received an average score of 86.25% in the good category. In addition, we received an average score of 90% in baseline condition 2 (A2), which put us in the very excellent group. This demonstrates that an IQ score of 114 has a very high level of craftsmanship, as seen by the fact that it has improved under all circumstances. Because there is a difference between the baseline condition and the intervention, Gast and Ledford are of the opinion that the gifted 2 subjects can be made more effective by applying the STAR strategy to mathematical creative thinking skills. This is due to the fact that there is a difference between the two.

Based on the findings of the efficiency of the two topics mentioned above, it can be concluded that the two subjects mentioned above are successful in teaching mathematical creative thinking abilities by using the STAR technique. Based on the outcomes of this research, it is possible to conclude that teaching talented kids mathematics using the STAR technique is an effective way to improve their capacity to think creatively about mathematics [18].

The results of this research showed that the researcher found the subject of G1 to be quite satisfactory in all conditions. This was due to the fact that the researcher was able to maintain his creative thinking pattern, and the subject of G1 also had a solid understanding of what the questions meant. One of the characteristics of talented children is that they are creative and want to do things in their own unique manner. This finding is consistent with her viewpoint [17]. Based on the findings of oral interviews with their two subjects, subject G1 from a set of research activities is still categorized as weak in flexibility indicators. This generalization is based on the findings of the interviews. Assume that since the solution to the problem has been identified, they are less inclined to explore for other possible solutions to the problem [19, 20]. During the course of the research, subject G1 only provided a single response to questions that may be categorized as open questions.

However, when seen as a whole, the material covered in G1 earns an overall grade of very excellent for how well it satisfies the characteristics of mathematical creative thinking. During the process of carrying out the research, the value

obtained by subject G1 in session 2 on baseline condition 1 (A1) in question number 5, which inquired about the distinction between two tribes, dropped. Subject G1, who had an IQ of 122, completed the indicator of creative thinking capacity in less than sixty minutes, namely 49 minutes. The indicator consisted of five questions, and the responses that were supplied were, on the whole, fairly satisfactory. This demonstrates that G1 has a high level of attention as well as curiosity.

The results of research conducted on G2 participants are not significantly different from those conducted on G1 ones. Subject G2 is, under all and all circumstances, highly gratifying for the researchers. And the disadvantage is the same as the one with the G1 topic, which is the flexibility indicator. The G2 subject only has one response to the category of open-ended inquiry inquiries, which means that the flexibility indicator is still not met. During the implementation, subject G2, who has an IQ of 114, worked on problems in precisely fifty minutes, which demonstrates that subject G2 is not very dissimilar to subject G1. And the solutions that are provided are clear and concise, making them simple to comprehend for scholars. The number of G2 individuals who saw a drop occurred in two sessions: session 2 under baseline circumstances 1 and session 10 under intervention settings. Both of these sessions took place while the research was being carried out. During session 2, the subject G2 struggled to answer question number 1, and during session 10, he made a mistake when responding to the question.

4 Conclusion

Gifted children benefit from the availability of the STAR Strategy, which consists of Search, Translate, Answer, and Review. This strategy has a positive impact on the students' capacity to think creatively about mathematics. This include being sensitive to problems, having fluency, flexibility, originality, and expanding on ideas. Kids classified as talented 2 do not significantly vary from gifted 1 student in terms of their mathematics creative thinking skills. The outcomes of talented kids had been falling into the good category with a percentage of 81.6% prior to the implementation of the STAR system for learning. During the time that the STAR approach was being implemented, there was also an improvement, and it was placed in the "good" category with an 86.25% percentage. In addition, after the implementation of the STAR approach learning, talented children saw their grades improve to very excellent with a percentage of 90%. This is due to the fact that academically talented pupils have often worked on Olympic issues. On the other hand, the results of this research showed that the gifted 1 pupil had higher scores than the talented 2 children did, despite the fact that the gap between their scores was not very large.

Conflict of interest

The authors declare that there is no conflict regarding the publication of this paper.

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