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Analysis of Creative Thinking Ability of Grade X Students on Atmosphere Material Assisted by Augmented Reality

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ABSTRACT

This study aims to determine and analyze the creative thinking abilities of class X students on AR-assisted atmospheric material at SMAN 19 Surabaya. The type of research is a mixed method using the sequential explanatory method of the participant selection model. This population is 30 class X11 students. Data collection techniques use test instruments, interviews and documentation. The test uses 8 essay questions from the development of creative thinking indicators. The results of the study show the results of the creative thinking ability test with an average percentage of 78.27% with a moderate category. Meanwhile, for each creative thinking indicator, fluency scored 69.23%, flexibility scored 80.87%, originality scored 83.8% and elaboration scored 79.2%. Students' creative thinking abilities are formed from the interaction between individual potential, motivation, and a supportive learning environment. The implication is that teachers need to create an open classroom atmosphere, provide challenges that trigger divergent thinking, and encourage student collaboration in finding creative solutions.

INTRODUCTION

Modern education emphasizes the importance of mastering four core skills: creative thinking, critical thinking, communication, and collaboration (the 4Cs). To achieve these skills, the learning methods and tools used must be up-to-date (Nurhayati et al., 2024). The 4Cs concept focuses on skills and innovation in the educational process. Furthermore, the 4Cs concept also aims to enhance higher-order thinking skills (HOTS). Creative thinking reflects complex thinking skills (Mardhiyana & Sejati, 2016). Moma (2015) explains that creative thinking is a person's ability to analyze new information and combine unique ideas to solve problems. According to Kuslum et al. (2019), creative thinking is the ability to find various solutions or ideas to address problems. This skill is crucial for understanding meaningful learning and overcoming everyday problems. Students can develop creative thinking skills through several stages: combining ideas, discovering new ideas, planning the implementation of ideas, and implementing those ideas (Tohir et al., 2018).

According to Dewi et al. (2019), creative thinking skills can be identified by their ability to analyze data and provide varied problem-solving responses. High creativity indicates a person's ability to think creatively (Mulyaningsih & Ratu, 2018; Effendi & Farlina, 2017). Creative thinking indicators include four indicators: (1) fluency thinking, which is a student's ability to find more than one answer; (2) flexible thinking, which is a student's ability to provide varied solutions; (3) original thinking, which is a student's ability to produce their own answers using their own language and words that are easy

to understand; and (4) elaboration ability, which is a student's ability to develop ideas (Munandar, 2012). (Arini & Asmila, 2017).

Creative thinking skills are influenced by both internal and external factors. Internal factors include intrinsic motivation which explains the drive from within the student himself (Wang & Chang, 2022), cognitive style which is the way the student receives and processes the information he obtains (Prosekov et al., 2022), personality which explains the thought patterns he has and knowledge which explains the student's understanding of the material he has learned (Aziz, 2023), while external factors include the family and social environment (Jankowska & Karwowski, 2019; Emami, Rezaei, Valaei, & Gardener, 2022).

This ability is crucial for geography lessons, particularly for understanding natural phenomena such as the atmosphere. Atmospheric material, with all its complexity, often presents a challenge for students to fully grasp. Conventional learning often relies on static text and illustrations that sometimes fail to effectively convey the dynamics and interconnectedness of concepts (De Oliveira & De Oliveira, 2023).

With advances in technology in education, Augmented Reality (AR) applications offer innovative solutions that can enhance student understanding. The use of AR in learning allows students to directly interact with abstract concepts, provides clearer visualizations, and stimulates interest and creativity in studying relatively difficult, abstract topics. However, while AR has proven effective in various educational fields, challenges remain in optimizing its use in atmospheric material, which requires creative and in-depth student engagement. Creative thinking skills are essential for students to study and understand natural phenomena (Anjarsari, 2014). Therefore, it is crucial for teachers to optimize students' creative thinking competencies in learning (Dewi et al., 2019).

The main problem faced in learning atmospheric science is students' low creative thinking skills in understanding and applying the concepts taught. Students often struggle to connect the theory taught to real-life situations, which impacts their ability to think critically and creatively (Cahyaningsih et al., 2023). Learning that relies on traditional methods often fails to create the engagement needed to spark creative thinking in students (Lestari & Fitriyah, 2023).

Observations have shown that teachers often use inappropriate media, such as PowerPoint presentations, to convey material. Each material has its own characteristics and learning objectives. Inappropriate media alignment with the material and learning objectives results in less engaging, boring, and boring learning, resulting in passive and sleepy students, ultimately leading to suboptimal learning outcomes. This situation was found in research (Sutarto, 2017), which found that students were less active in the learning process, resulting in suboptimal learning outcomes.

This situation is common in all schools, including at SMAN 19 Surabaya. Teachers have not optimally selected media appropriate to the material being taught, media that motivate students, media that encourage creative and innovative thinking, and a pleasant learning environment that ultimately leads to optimal learning outcomes. In learning atmospheric material, many students are found to be less creative in solving problems, this is proven by answers that only come from textbooks (Fatmawati et al., 2022).

This situation is common in all schools, including at SMAN 19 Surabaya. Teachers have not optimally selected media appropriate to the material being taught, media that can motivate students, media that encourage creative and innovative thinking, and a pleasant learning environment, thus optimizing learning outcomes. In learning about the atmosphere, many students lack creativity in problem-solving, as evidenced by answers that are solely sourced from textbooks (Lestari & Fitriyah, 2023).

Based on observations, it can be seen that the learning process is still lacking attention, resulting in students being less accustomed to creative thinking. Furthermore, the lack of creative thinking skills in class X11 students is due to a lack of imagination and divergent thinking skills, which affect the extent to which students can generate new ideas and creative solutions. This study aims to explore how AR is applied in learning about the atmosphere for class X11 students at SMAN 19 Surabaya. The second research objective is to analyze the creative thinking skills of class X11 students on the atmosphere material assisted by AR at SMAN 19 Surabaya .

Although numerous studies have been conducted on the use of AR in geography lessons, there is still little focus on developing student creativity, particularly in atmospheric concepts. Previous research has focused more on improving conceptual understanding, while the impact of AR on creative thinking skills remains understudied. Therefore, this study aims to address this gap by providing a more focused and practical approach to developing creativity through AR technology in atmospheric learning.

The uniqueness of this study lies in the use of AR to teach the complex and abstract topic of atmospheric concepts. Furthermore, this study will assess the extent to which AR can foster student creativity in solving problems related to atmospheric concepts. Therefore, this research is highly relevant, especially considering the rapid technological advances in education and the demand to maximize the use of such technology to improve the quality of learning and student creativity.

METHODE

Research Design

The research used a mixed method, a combination of quantitative and qualitative research (Firdausi et al., 2018). The quantitative data in this study consisted of the percentage of students' creative thinking skills. Qualitative data were obtained from

interviews explaining the factors influencing students' creative thinking skills. The research design used in this study is a mixed design with dominant-less dominant, where the sequential explanatory type is the participant selection model (Mustaqim, 2016). The following are the research steps in the participant selection model design.

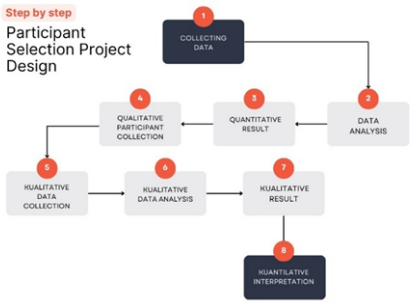

Figure 1. The Steps of at Desain Participant Selection Model

Population and Sample

This research was conducted in May 2024 in grade 11 students at SMAN 19 Surabaya. The population is all units of analysis used for the research, while the sample is a sample taken from the population for this study (Narimawati et al., 2020). The population used in this study included all 11 classes at SMAN 19 Surabaya about 329 students. The sample was grade 11, consisting of 30 students. Class selection was random because all classes had similar characteristics and therefore had an equal chance of being selected as samples. The technique used was probability sampling with simple random sampling (Siyoto & Sodik, 2015).

Research Instrument

The instrument used was an interview test sheet containing eight questions aligned with the creative thinking indexes according to Munandar (2012): fluency thinking, flexible thinking, original thinking, and elaboration thinking. The instrument was then validated by three expert validators using a Likert scale to determine the instrument's suitability.

Data Collection Procedure

Quantitative data were collected by administering a creative-thinking assessment to all participants, while qualitative data were gathered via semi-structured interviews. Based on their test scores, participants were divided into three categories (high, medium, and low). Subsequently, representative individuals from each category were interviewed in order to investigate the underlying factors that might influence their creative thinking abilities. Semi-structured interviews provide a structured yet flexible format that allows the researcher to probe further while adhering to thematic guides (Magaldi & Berler, 2020). Meanwhile, using stratification of quantitative scores and then selecting participants for interviews is a common mixed-methods strategy to deepen understanding of quantitative findings (Schoonenboom, 2024).

Data Analysis

This research was analyzed through two stages, namely quantitative and qualitative analysis. The quantitative data were analyzed using descriptive statistics, which describe the percentage of the total scores obtained by students (Sugiyono, 2019). The scoring criteria were based on a modified scoring rubric from Moma (2015). The formula for determining the percentage of students' creative thinking scores was adapted from Putra et al. (2018) as follows.

$$Value = \frac{Score\ Student}{Score\ Maximum\ Ideal}\ x\ 100 \ldots\ldots\ldots \quad (1)$$

After knowing the percentage of students' creative thinking abilities, then using the formula from Setiawan (2018), it is categorized into high, medium, and low with the following mean and standard deviation calculations.

$$M = \frac{\sum x}{N} \ldots\ldots\ldots (2)$$

Additional information:
M : Mean
Σx : Number of points obtained
N : total of student

The next step is to calculate the standard deviation using the following formula (Effendy & Muin, 2018) below.

SD= Σ (x-x2)(n-1) …… (3)

Additional information:
SD : Standar deviation
∑x : sum of all deviations
∑x2 : The sum of all deviations, after squaring
N : sum of all deviations

After the calculation results are known, continue by grouping the levels of creative thinking as shown in Table 1 below.

Table 1. Grouping of Creative Thinking Skill Levels
Source: Modification of (Sariningsih & Herdiman, 2017)

Persentase Score	Category
P ≥ (M + SD)	High
(M – 1 SD) < P < (M + 1 SD)	Medium

P ≤ (M − 1 SD)	low

Tabel 1. Grouping of Creative Thinking Skill

The calculation continues by calculating the percentage of overall indicator achievement to determine the extent of achievement of the creative thinking ability indicator. This study uses formula 4 below.

$$P = \frac{\sum R}{SM}$$

The calculation continues by calculating the percentage of overall indicator achievement to determine the extent of achievement of the creative thinking ability indicator. This study uses formula 4 below.

$$P = \frac{\sum R}{SM}$$

Additional information:

P : Percentage value of creative thinking ability
∑R : scores obtained by students
SM : maximum score of all students

After quantitative data analysis, qualitative data analysis was conducted using Miles and Huberman's data analysis method, which consists of several steps (Rijali, 2019), as follows:

1. Data Collection
   Data collection was conducted by administering an interview test to students with high, medium, and low creative thinking ability levels. The interview results were presented in descriptive form.
2. Data Reduction
   Data reduction facilitates drawing conclusions. The reduced data consisted of answers from interviews with class X11 students at SMAN 19 Surabaya, categorized as high, medium, and low.
3. Data Presentation
   The data presentation contains information organized in descriptive form for easier understanding. The data presentation includes explanations of the interview results and factors influencing creative thinking ability in the high, medium, and low categories.
4. Conclusion Drawing
   Conclusions were drawn using triangulation techniques. Data triangulation was conducted using tests and interviews to obtain consistent or consistent data to reach accurate research conclusions.

After conducting quantitative data analysis, qualitative data analysis was then carried out from interviews using data analysis from Miles and Huberman which consists of several steps (Rijali, 2019) as follows.

RESULT AND DISCUSSION

Students' Creative Thinking Skills

Students' creative thinking skills were measured by their scores in an interview test, where data collection took place in the classroom. Each student's score was calculated using Putra's (2018) formula, which categorizes creative thinking skills as shown in Table 2. Table 2 shows that all 11th-grade students took the test, with 5 students (16.7%) receiving low scores, 19 students (63.3%) receiving medium scores, and 6 students (2%) receiving high scores. The distribution of students' creative thinking skill

Table 2. Level of creative thinking ability of class X11 students at SMAN 19 Surabaya

Student	Fluency	Flexibility	Originality	Elaborasi	Total	Mean	Category
1	50	82	82	80	294	73.5	Low
2	70	85	87	88	330	82.5	High
3	65	82	90	70	307	76.75	Medium
4	65	80	78	86	309	77.25	Medium
5	65	84	82	85	316	79	Medium
6	70	85	85	86	326	81.5	High
7	55	85	85	68	293	73.25	Low
8	75	92	90	82	339	84.75	High
9	70	86	82	86	324	81	Medium
10	70	81	80	78	309	77.25	Medium
11	65	78	82	84	309	77.25	Medium
12	55	69	86	76	286	71.5	Low
13	60	75	82	74	291	72.75	Low
14	75	66	86	82	309	77.25	Medium
15	65	76	92	82	315	78.75	Medium
16	60	68	78	83	289	72.25	Low
17	70	79	83	78	310	77.5	Medium
18	65	80	85	82	312	78	Medium
19	65	76	80	79	300	75	Medium
20	75	76	84	80	315	78.75	Medium
21	75	79	87	84	325	81.25	Medium
22	80	75	85	72	312	78	Medium
23	75	85	86	88	334	83.5	High
24	76	87	80	76	319	79.75	Medium
25	77	80	82	85	324	81	Medium
26	80	92	90	72	334	83.5	High
27	70	92	88	62	312	78	Medium
28	80	86	86	58	310	77.5	Medium
29	79	70	72	90	311	77.75	Medium
30	75	95	79	80	329	82.25	High

Based on the test results in Table 2, it can be seen that the average level of students' creative thinking ability is 78.27%, which indicates a medium group category. The average value is obtained by adding up all the student percentage results divided by the number of students. Where students in the high group category are 6 students or 2%, 19 students are included in the medium category or 63.3% and 5 students are included in the low group or 16.7%. The grouping of creative thinking abilities of class X11 students at SMAN 19 Surabaya can be made in Figure 3 as follows.

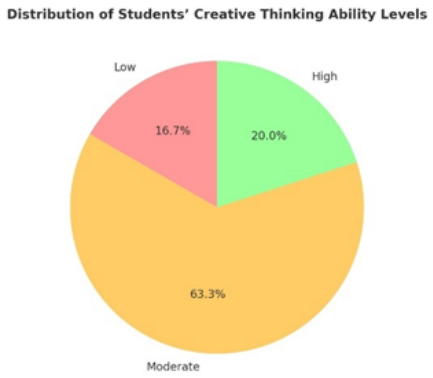

Figure 3. Distribution of creative thinking ability categories of class X11 students at SMAN 19 Surabaya

In Figure 3, it can be seen that more than half of the class or 19 students (63.3%) of the X11 class students at SMAN 19 Surabaya are in the medium category, followed by the high group with 6 students or 2%, and the remaining 5 students or 16.3% are in the low category. Meanwhile, to find out the distribution of each indicator of creative thinking ability of class X11 students at SMAN 19 Surabaya, it can be seen in table 3 below.

Table 3. Percentage of creative thinking indicators

No.	Indicators of creative thinking ability	Percentase (%)	Creative thinking category
1.	Fluency	69,23	Low
2.	Flexibility	80,87	Medium
3.	Originality	83,8	High
4.	Elaboration	79,2	Medium

Table 3 shows that each indicator of creative thinking ability has a different percentage. The Fluency indicator has a low percentage of 69.23%, while the Flexibility indicator has a moderate percentage of 80.87%. The Originality indicator has a high percentage of 83.8%, and the Elaboration indicator as a moderate percentage of 79.2%. The data in Table 3 shows that the highest percentage achievement is found in the originality indicator.

The findings of this study reveal that the overall creative thinking ability of 11th-grade students at SMAN 19 Surabaya falls within the medium category, with an average score of 78.27%. Specifically, 63.3% of students were categorized as having moderate creative thinking skills, 16.7% as low, and only 2% as high. These results indicate that while the majority of students have achieved a sufficient level of creative thinking competence, there remains considerable room for improvement, particularly in elevating more students to the high-performance group.

This distribution aligns with recent studies showing that creative thinking abilities among secondary students in many educational contexts tend to cluster around the medium level. Research suggests that this pattern is influenced by several factors, including instructional strategies, classroom learning environments, and students' prior cognitive development (Jung, Lim, & Jo, 2025; Vonny, Sigit, & Supriyatin, 2023). Traditional teacher-centered learning approaches often limit opportunities for divergent thinking, thereby inhibiting students from reaching higher levels of creativity (Ritter et al., 2020).

When examining each indicator of creative thinking, the originality indicator achieved the highest score (83.8%), indicating students' relative strength in producing unique ideas. This is consistent with the notion that adolescents often demonstrate originality when given open-ended tasks (Sinduningrum et al., 2023). However, the fluency indicator showed the lowest score (69.23%), suggesting that students struggle to generate a large number of ideas within a given problem context. Previous research highlights that fluency is often the most challenging aspect of creative thinking to develop, as it requires not only imagination but also flexible retrieval of prior knowledge (Yunadia et al., 2023; Kenett, 2024).

The flexibility and elaboration indicators were in the moderate range (80.87% and 79.2% respectively), indicating that students are capable of adapting their ideas and adding detail but may not be consistently pushed toward more complex and structured creative output. Others studies emphasize that sustained engagement in problem-based learning and project-based learning environments can significantly improve these components of creative thinking (Illahi et al., 2022; Arifatin, 2023). Therefore, in this study, it is still necessary to implement project-based learning elaboration by utilizing Augmented Reality media in the Atmosphere material to encourage students to produce creative work.

The dominance of medium-category scores in this study suggests that the current learning environment may provide limited but existing opportunities for creative engagement. This aligns with findings that students' creative thinking skills are highly sensitive to pedagogical approaches; active learning and inquiry-based strategies have been found to enhance creative capacity more effectively than conventional lecture methods (Kozanitis & Nenciovici, 2022; Sam, 2024). Therefore, targeted instructional interventions are needed to boost fluency and elaboration skills while sustaining high performance in originality.

Overall, these findings underscore the importance of integrating creativity-focused pedagogical models into the classroom. Encouraging divergent thinking, problem-solving, and reflective practices can help shift the distribution from medium toward higher creative performance levels (Gu et al., 2022; Ritter & Mostert, 2017; Runco, 2022). Future research should explore longitudinal interventions to assess how

sustained creative learning environments impact different dimensions of creative thinking.

FACTORS INFLUENCING STUDENTS' CREATIVE THINKING SKILLS

The results of the study indicate that the average creative thinking skill of tenth-grade students was 78.27%, indicating that students were able to develop ideas, view problems from multiple perspectives, and generate meaningful ideas. However, the results showed that the fluency indicator scored 69.23%, which is considered low. According to Arini & Asmila (2017), fluency is the ability to think fluently, a student's ability to provide a variety of answers. Meanwhile, according to Munandar (2012), fluency is the ability of students to generate ideas and answers to solve problems.

The fluency indicator score for class X11 students at SMAN 19 Surabaya, which was 69.3%, indicates a barrier in the divergence phase, which impacts students' ability to generate new ideas and creative solutions. This means that although students have ideas, they ultimately struggle to develop them. Factors such as evaluative anxiety, lack of self-efficacy, limited basic knowledge, and learning habits are inhibiting factors.
During learning activities, teachers are less able to motivate student creativity through learning models or media. By using augmented reality (AR) learning media, students become more interactive. AR applications enable students to learn in a more fun and engaging way. The integration of visual and interactive elements helps focus students' attention, reduces boredom, and increases motivation to learn. The AR application and student interaction can be seen in Figure 4 and Figure 5 below.

Figure 4. AR application of atmospheric material

Figure 5. Student interaction during AR use

According to Arini & Asmila (2017), flexibility is the ability to generate diverse ideas. Meanwhile, according to Munandar (2012), flexibility is the achievement of students' indicators in providing varied solutions (from all angles). The results of the study showed that the flexibility indicator scored 80.87%, or categorized as moderate, indicating that students are still limited in generating a variety of ideas. Students can provide varied answers but are not flexible enough to deal with complex problems. This is often due to students' limited prior knowledge and lack of practice in complex thinking.

Learning models play a crucial role in enhancing student creativity. The learning models chosen by teachers at SMAN 19 Surabaya must be implemented correctly. Likewise, the learning media used must foster creativity. For example, with the use of AR, teachers can provide stimulation, open-ended questions, and appreciation for diverse ideas. The use of AR can foster interest and encourage exploration and the pursuit of new ideas.

To increase flexibility, efforts are needed to enrich students' prior knowledge, provide challenging assignments that encourage complex thinking, and create a conducive classroom atmosphere. Furthermore, access to technology, varied teaching materials, and supporting resources that explore ideas help students experiment. A curriculum that provides space for critical and creative thinking (e.g., the Independent Curriculum) provides greater opportunities for students to develop their creativity.

Originality is the ability to express one's ideas according to one's own opinion (Arini & Asmila, 2017). According to Munandar (2012), originality is the ability of students to produce unique answers (using their own language or words that are easy to understand). The study results showed that the originality indicator scored 83.8%, which is considered high. This means that class X11 students at SMAN 19 are able to generate unique ideas, using their own language, that differ from other answers. Originality refers to the ability to generate ideas that are rarely encountered in a group and are relevant to the problem. This shows that students have the ability to break out of typical answer patterns and generate fresher ideas, driven by the ability to connect unusual concepts and extensive learning experiences.

In the learning process, students' ability to think creatively is influenced by both internal and external factors. Internal factors include an open attitude to experience, a

desire to learn, and the courage to take risks, which can lead to innovative ideas. External factors include access to technology, a variety of learning materials, and facilities that support the exploration of ideas, which help students experiment in new ways.

The application of augmented reality in atmospheric materials for tenth-grade students at SMAN 19 Surabaya can help enhance students' creative thinking. Personal factors such as intrinsic motivation and belief in creativity contribute significantly to originality. Internal motivation can include interest and the drive to explore, try new things, and solve problems. Students with a strong sense of curiosity and interest in a task tend to be more willing to propose unique ideas. Furthermore, a positive learning environment where teachers provide stimulation, ask open-ended questions, and value diverse ideas can foster student creativity.

According to Arini and Asmila (2017), elaboration is a student's skill in developing their ideas. Meanwhile, according to Munandar (2012), elaboration refers to a student's ability to expand on an idea or explain an answer in detail. Research shows that the elaboration indicator scored 79.2%, which falls into the moderate category. This indicates that students still have difficulty developing and validating their ideas thoroughly. In the context of creativity, elaboration is the ability to expand on an idea or explain an answer in detail (Munandar, 2012). This moderate category indicates that although students can explain their ideas, the depth of their arguments and the systematic nature of their answers are still lacking.

This condition was evident during learning using AR, where eleventh-grade students demonstrated the ability to explain answers in detail, but many of them experienced difficulty developing those answers. This was due to minimal prior learning experience. Rich experience in various situations provides students with more reference material to combine concepts and think innovatively. These experiences can be used as capital to expand ideas. It appears that these eleventh-grade students lack experience, so they have not been able to optimize the elaboration indicator.

In addition to intrinsic factors, extrinsic factors also influence learning, such as support from family and the social environment. For example, parents who provide freedom, support their children's interests, and stimulate creativity through activities at home can strengthen these abilities. However, the situation among eleventh-grade students at SMAN 19 Surabaya shows that most receive insufficient support from their families because their parents pay little attention to their children's education, resulting in them not fully understanding their children's educational needs.

CONCLUSIONS

The results of this research indicate that the overall level of creative thinking among 11th-grade students at SMAN 19 Surabaya is positioned in the medium range, with a mean score of 78.27%. Most of the students (63.3%) performed at a moderate level,

while only a small proportion (2%) reached a high level, and 16.7% were categorized as low performers. Among the four indicators assessed, originality recorded the highest percentage (83.8%), suggesting that many students are capable of producing distinctive and personal ideas. Meanwhile, flexibility (80.87%) and elaboration (79.2%) were both at a moderate level, reflecting students' capacity to approach problems from multiple angles and provide explanations with sufficient detail. In contrast, fluency was the weakest indicator (69.23%), revealing difficulties in generating a wide variety of ideas and alternative solutions.

These findings reveal that creative thinking skills are shaped by a combination of internal and external factors. Internal factors include students' intrinsic motivation, openness to new experiences, and willingness to take intellectual risks. External factors involve the classroom environment, pedagogical strategies, and the use of appropriate technology. The integration of augmented reality (AR) in learning activities appears to have increased student participation, encouraged exploration, and supported the development of original thinking. Nevertheless, limited learning experiences, insufficient elaboration skills, and a lack of family support remain significant obstacles to the optimal development of creative potential.

RECOMMENDATION

For future implementation, several recommendations are proposed for:

1. Schools could adopt interactive and inquiry-based learning strategies, particularly through the integration of augmented reality (AR), to strengthen students' creative thinking across fluency, flexibility, originality, and elaboration.
2. Teachers should improve students' creative thinking skills by utilizing learning media, learning models, stimuli, open-ended questions, and rewards.
3. Further research is needed to evaluate progress in creative thinking skills and the effectiveness of these skills in students.
4. Future research should employ more rigorous designs, involve larger and more diverse populations, and consider socio-cultural variables to yield deeper and more generalizable insights into the development of creative thinking skills.
5. Professional development for teachers should emphasize creative pedagogy and effective technology use, while curricula must position creativity as a central learning objective.
6. Active family and community engagement is essential to create an encouraging environment that fosters students' motivation and confidence.

LIMITATION AND IMPLICATION

Research Limitation

This study is constrained by several important limitations, including: 1) the small sample size of 30 students from a single class limits the generalizability of the findings, while the exclusive use of descriptive statistics limits the ability to draw causal conclusions between teaching strategies and creative development. 2) reliance on a single data collection method reduces the depth and triangulation of insights. 3)

contextual variables such as family background and socioeconomic conditions are not adequately explored, potentially overlooking important factors that shape students' creative capacities.

Research Implications

Despite the limitations, the study offers significant implication for future studies. Teachers need to create an open classroom atmosphere, provide challenges that trigger divergent thinking, and encourage student collaboration in finding creative solutions. Future research should be done with larger and more diverse samples to enhance the generalizability of the findings. Employing inferential analysis and multiple data collection methods would strengthen the validity and depth of the results. Future research should explore longitudinal interventions to assess how sustained creative learning environments impact different dimensions of creative thinking. Moreover, incorporating contextual variables such as family background and socioeconomic conditions would provide a more comprehensive understanding of students' creative development.

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