Child Education Journal (2025), **7.1**, 12–25

Child Education Journal

The effectiveness of GaMaKe Media to train creative thinking in early childhood

Mallevi Agustin Ningrum[1*], Afifah Rahmaningrum[2], Melia Dwi Widayanti[3], Kartika Rinakit Adhe[4]
[1]Department of Early Childhood Education, Universitas Negeri Surabaya, Surabaya, Indonesia

[*]Corresponding author:
malleviningrum@unesa.ac.id

Article Information:

Submission	:	May 04, 2025
Revision	:	May 20, 2025
Accepted	:	May 21, 2025
Available Online	:	June 10, 2025
doi	:	10.33086/cej.v7i1.7272

Abstract

Creative thinking (CrTS) is one of the most important skills in the era of Society 5.0. The disparities that occur in creative thinking indicators are often experienced by children from an early age, especially in the indicators of originality and elaboration. This study aimed to test the GaMaKe (Firefighter Game) media as a solution to train indicators of CrTS in early childhood. GaMaKe media integrates game elements with fire disaster mitigation-based activities to provide meaningful experiences for early childhood. This research method uses pre-experimental with a one-group pre-test and post-test design with 54 children divided into three groups. The research results show that GaMaKe media can improve creative thinking in early childhood, showing significant results; the average N-Gain for class A is .53, class B is .57, and class C is .62, which is categorized as moderate; and there is no difference in the average N-Gain score through statistical testing of the Paired Sample T-test.

Keywords: Media GaMaKe, creative thinking, early childhood, disaster mitigation.

INTRODUCTION

Early age is a critical age range, meaning that children receive various stimulations that are essential for their development (Foster et al., 2024). This age is a central point in helping children to acquire advanced skills in pursuing basic education (Johnson et al., 2019) (Attanasio et al., 2022) (Beaver et al., 2018). This statement is in line with the aim of developing the Sustainable Development Goals (SDG's) in number 4, where quality education is very important to fulfill as a primary need in the life of every child (Sdg, 2019) (Katila et al., 2019) (Halkos and Gkampoura, 2021).

The 21st century currently requires skills that will be useful in the future, which are given the acronym 4C, including communication, collaboration, critical thinking, and creative thinking (CrTS) (Su et al., 2022). These skills are needed by children to be able to face the challenges of an unpredictable future (Eyni et al., 2021) In the modern era, education places more emphasis on the process of acquiring the skills needed for teaching and learning without age restrictions (Bal, 2019) (Hwang and Chien, 2022) (Ouyang and Jiao, 2021).

CrTS is one of the essential skills that need to be developed from an early age (Azaryahu et al., 2023). These skills are important to help children generate innovative ideas/thoughts and flexibility of thinking that will be useful throughout their lives (Yildiz and Yildiz, 2021); (Stolte et al., 2022) (Durnali et al., 2023) (Vijayakumar Bharathi and Pande, 2024). Early CrTS stimulation is very important to be carried out in order to develop knowledge and produce new ideas (Alabbasi et al., 2022) (Chen et al., 2022) (Acar et al., 2023), so that it is useful for other people around him. Based on the theory (Torrance, 1966) conveyed that there are four indicators including fluency, flexibility, originality, elaboration.

Findings in various countries also show that children's CrTS is important to improve in the 4.0 era in China using digital equipment (Wang and Li, 2024). Another analysis took place in Türkiye regarding a new program to train creative thinking in children (Balci et al., 2024). Research in Qatar also showed that there was an increase in CrP in primary school children through STEM (Saad et al., 2024). Enhancing scientific creativity in secondary school students in Türkiye through problem-based learning and Cognitive Research Trust (CoRT) teaching modules (Ates and Aktamis, 2024). This study highlights something different from previous studies, namely the use of GaMaKe media in stimulating CrTS in children aged 5-6 years with fire disaster mitigation material.

The 2022 PISA data shows that the science score involving CrTS is ranked 74th out of 79 countries participating in PISA (İdil et al., 2024) (Deta et al., 2024). This shows low data on the CrTS indicators, especially on the elaboration and originality indicators. This finding supports previous research which shows that CrTS skills still show low numbers. (Hasnah et al., 2024); (Irwan et al., 2024); (Muchson et al., 2024) (Widyaningtyas et al., 2024). Facts on the ground show that the implementation of learning aimed at training CrTS in early childhood still faces various challenges. The lack of interesting and interactive learning media is often an obstacle in creating a learning environment that supports the development of children's CrTS (Nadia et al., 2022) (Rachman et al., 2024).

As research has been conducted, it shows that CrTS is still not significantly stimulated in children, because learning is still centered on the teacher so that it does not explore children's creative thinking enough (Jankowska et al., 2019). An approach that integrates play and learning activities has been shown to be effective in facilitating children's cognitive, social, and emotional development (Vartiainen and Kumpulainen, 2020). Previous research explains that by playing and integrating technology in learning, early childhood children can understand many things that happen around them in a concrete way (Coates and Pimlott-Wilson, 2019) (Spicer, 2020) (Kulju and Mäkinen, 2021). This study follows up on the results of previous research and brings innovation to utilize technology in the form of game applications in providing fire disaster mitigation materials that are adapted to the characteristics of early childhood.

Therefore, in improving the CrTS indicators, it is accompanied by the presence of technology such as learning through games or technology-based applications that can provide different experiences and facilitate children to find new things in their surroundings to survive in this modern era (Johnson et al., 2019). Interesting, innovative, and concrete games can improve CrTS indicators in early childhood (Gamanik et al., 2019) (Whitebread and O'Sullivan, 2020) (Fleer, 2021) (Chen et al., 2022). This research is important to provide new insights into early childhood learning practices using interactive media that can be accessed easily and specifically to train children in CrTS indicators.

Based on these principles, GaMaKe Media is used in this study as an innovative solution designed to train children's CrTS indicators through a fun and integrated approach. The novelty of this research is the use of innovative media that combines game elements and role-playing that actively involve children in the learning process with fire disaster mitigation material that is adapted to the characteristics of early childhood.

Fire is a disaster situation that must be watched out for and anticipated because it can cause respiratory illnesses and even death, property loss and social loss (Krichen et al., 2024). In an effort to prevent fire disasters from occurring, children can be given fire disaster mitigation materials to prepare themselves before a disaster occurs, during evacuation and relocation (Brown, 2013) (Tatebe and Mutch, 2015) (Pohan et al., 2024). Therefore, it is very important to introduce fire disaster mitigation material to early childhood.

The formulation of the research problem is how effective is the GaMaKe media in improving children's creative thinking? So the aim of this research is to analyze the results of the effectiveness of the GaMaKe media in training children's creative thinking. Thus, it is hoped that GaMaKe media can be an effective solution in answering the need for creative learning in the field of early childhood education.

MATERIALS AND METHOD

2.1 Materials

This study used a pre-experimental design with a one group pre-test post-test without a control class with three classes called class A, class B, and class C. The CrTS test uses individual worksheets completed by each child to measure indicators of fluency, flexibility, elaboration, and originality. The research design is presented in Table 1.

Table 1. Experimental Research Design

Group	Pre-test (O1)	Treatment	Post-test (O2) (X)
A	Test CrTS	GaMaKe Media	Test CrTS
B	Test CrTS	GaMaKe Media	Test CrTS
C	Test CrTS	GaMaKe Media	Test CrTS

Table 1 explains that pre-test activities were conducted in three trial classes to measure children's critical thinking before being given treatment. Furthermore, GaMaKe media was used as a treatment in three trial classes. Finally, post-test activities were conducted in three trial classes after being given treatment to measure children's creative thinking.

2.2 Data collection procedures

The research period was conducted from September 2023 to January 2025 in three classes at TK Muslimat NU 124 Al Akhsan, Benjeng District, Gresik Regency. The saturated sampling technique used in the study is a sampling technique in which all members of the population are used as samples. The entire population is used as research subjects without random sampling. This technique was chosen in order to ensure that the data obtained is comprehensive and representative of the entire population targeted by the study. This technique is used because the population is relatively small and still allows for research as a whole. The population includes all children in three classes totaling 54 children, with details of each class consisting of 18 children.

2.3 Data analysis procedures Research Instrument

Validation of the GaMaKe research instruments and media was carried out by three experts who are experts in the field of early childhood education. The results of the validity and reliability tests can be shown in Table 2.

Table 2. GaMaKe Media Validation Results

Validated Aspects	Validation Results			Average	Criteria
	Expert 1	Expert 2	Expert 3		
CrTS observation sheet instrument	4.00	3.92	3.95	3.96	Very valid
Children's activity observation sheet instrument	3.95	3.98	3.94	3.96	Very valid
Average	3.98	3.95	3.94	3.89	Very valid
	Alfa Cronbach	(a)		.90	Very realiable

According to Table 2, it appears that the results of the validation of the research instruments and GaMaKe media in this study are in the average score range of 3.89-3.96 with a very valid category. The results of the reliability test of the research instrument and GaMaKe media were 0.90, which is categorized as very reliable. This analysis shows that the GaMaKe research instrument and media are suitable for use in research.

Research Procedures

The One-Group Pretest-Posttest research design in three experimental classes, including the data collection process, can be presented in Diagram 1.

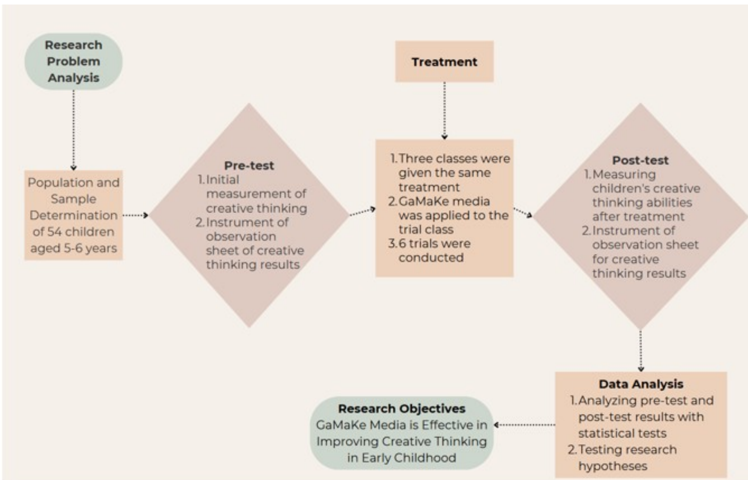


Diagram 1. Prosedur Penelitian

Diagram 1 shows the flow of experimental research with One-Group Pretest-Posttest design conducted in three experimental classes using saturated sample technique, in which 54 children were used as research subjects. The pretest stage was conducted in order to measure children's initial creative thinking abilities, then the same treatment using GaMaKe media was given to the three trial classes. Furthermore, a posttest was conducted to determine the changes that occurred after the treatment was carried out. The pretest and posttest data were analyzed to assess the effectiveness of the treatment used in drawing research conclusions.

Data Analysis

GaMaKe Instrument and Media Validity Results

The validation process for the research instruments and GaMaKe media was carried out by involving three experts using qualitative descriptive data analysis. The validation results assessment is carried out according to Table 3.

Table 3. Validation Results Assessment Criteria

Score	Criteria
3.25 p < 4.00	Very valid
2.50 p < 3.25	Valid
1.75 p < 2.50	Currently
1.00 p < 1.75	Not enough

The results of the reliability test of the research instruments and GaMaKe media can also be shown in Table 4.

Table 4. Cronbach's Alpha Assessment Criteria

Interval Cronbach Alfa (a)	Criteria
.90 a 1	Very reliable
.70 a < .90	Reliable
.50 a < .70	Quite reliable
<.50	Not reliable

Based on Tables 3 and 4, the results of the validity assessment meet a minimum score of 2.50, meeting the valid criteria, while the results of the reliability reach a minimum score of .70, which is categorized as reliable.

GaMaKe Media Practical Results

This research was conducted by two observers who observed the implementation of GaMaKe media to improve children's CrTS through an observation sheet instrument. The assessment criteria for implementing learning using GaMaKe media are presented in Table 5.

Table 5. Criteria for Assessing the Implementation of Learning with GaMaKe Media

Score	Assessment Criteria
3.50 p 4.00	Very good
2.50 p < 3.50	Good
1.50 p < 2.50	Pretty good
1.00 p < 1.50	Not good

According to Table 5, the results of the practicality of the GaMaKe media were analyzed using qualitative descriptive with a minimum score range of 2.50 in the practical category.

The results of the effectiveness of GaMaKe Media

The research instrument used to measure CrTS and children's responses in participating in learning using GaMaKe media was carried out by two observers. The analysis of the effectiveness results data was carried out using qualitative descriptive methods and using the N-Gain value:

$$N - \text{Gain} = \frac{S_{\text{post}} - S_{\text{pre}}}{S_{\max} - S_{\text{pre}}}$$

Information:
N-Gain = normalized gain value (normalized gain)
Spost = CrTS post-test score
Spre = CrTS pre-test value
Smax= maximum CrTS value

The N-Gain assessment criteria can be presented in Table 6.

Table 6. N-Gain Criteria

Score N-Gain	Criteria
.70 < N-Gain	Tall
.30 N-Gain .70	Currently
N-Gain < .30	Low

According to Table 6, children's responses in learning using GaMaKe media were carried out using qualitative descriptive analysis with a minimum score of 50 with active criteria, which are summarized in Table 7.

Table 7. Criteria for Children's Activities

Percentage (%)	Criteria
0–24	Not active
25–49	Less active
50–74	Active
75–100	Very active

RESULT AND DISCUSSION

3.1 Result

GaMaKe Media Validity Results

The GaMaKe media validation process was carried out by three experts in the field of early childhood education. The validation results are shown in Table 8.

Table 8. GaMaKe Media Validation Results

Assessment Aspects	Validator Score			Average	Criteria
	xpert 1	xpert 2	xpert 3		
Media Material Validation	4.00	4.00	4.00	4.00	Very valid
Media Component Validation	4.00	3.82	3.87	3.89	Very valid
Average	4.00	3.91	3.93	3.95	Very valid
	Alfa Cronbach	(a)		.92	Very realiable

Table 8 shows that the results of the validation of the GaMaKe media material show an average score of 4.00, which is categorized as very valid. The average score of the validation results of the GaMaKe media components was 3.89, fulfilling the very valid category, and the reliability results fulfilled the average score of .92 with the very reliable category. These data conclude that the media is declared valid and reliable so it is suitable for use in collecting research data.

GaMaKe Media Practical Results

Based on the analysis of the validity results, GaMaKe media is declared suitable for implementation in learning. This media is applied to children by playing individually and taking turns between one child and another using an android. The results of implementing GaMaKe media in class are shown in Figure 1.

Figure 1. Children Playing with GaMaKe Media

According to Figure 1, it appears that children use GaMaKe media independently without guidance, so that teachers provide guidance to children if necessary. This shows that GaMaKe media can be easily accessed by children in class. After working on the GaMaKe media, the teacher then applies the role play method to support children's understanding of fire disasters using direct practice. This data is presented in Table 9.

Table 9. Role Play for Fire Disaster Mitigation

Activity Documentation	Description
	The fire disaster situation is depicted by the presence of flames in a miniature house which must be handled immediately to extinguish the fire.
	The facilitator enthusiastically briefed the children who were playing the role of the fire brigade team.
	Children accompanied by a team of firefighters and teachers simulate extinguishing a fire so that it can be extinguished quickly using a fire extinguisher.
	Children carry out independent simulations to extinguish fires according to the instructions and examples given by the firefighting team.
	Simulation to help unconscious fire victims to be taken to a safe place to receive early medical treatment.
	Children act as doctors accompanied by nurses to provide proper assistance to fire victims.
	The children were very enthusiastic in participating in the role play activities to understand the fire disaster simulation material from the beginning to the end of the activity.

Note: Documentation by researcher

Table 9 shows that the fire disaster mitigation material has been carried out by combining role play methods, children play the roles of planned characters such as firefighters, doctors, nurses, and groups who are in a fire disaster situation. Children are very enthusiastic when doing role play activities with several tools provided by the teacher, so that the fire disaster mitigation material can be understood by children using direct practice. In addition, data on the practicality of GaMaKe media is also summarized in Table 10.

Table 10. Results of Validation of Research Instruments and GaMaKe Media

Learning Design	Learning Implementation				
	Class A	Class B	Class C	Classroom Atmosphere	Time Management
RPP 1	3,4	3,3	3,4	3,3	3
RPP 2	3,3	3,4	3,3	3,4	3,1
RPP 3	3,3	3,5	3,6	3,5	3,3
RPP 4	3,6	3,5	3,7	3,6	3,5
RPP 5	3,7	3,6	3,8	3,7	3,7
RPP 6	4	3,9	4	3,9	4
Average	3,55	3,53	3,63	3,57	3,43
Reliability Level (%)	88,75	88,3	90,8	89,17	85,83
Category	SP	SP	SP	SP	SP

Description: SP = Very practical P = Practical CP = Very practical
KP = Less practical TP = Not practical

According to the presentation in Table 10, it can be concluded that the implementation of learning in the trial class meets the criteria of being very practical for RPP 1-6, meanwhile, the classroom atmosphere achieved an average score of 3.7 and time allocation management with an average score of 3.43, so both meet the criteria of being very practical. Teachers have conducted learning using GaMaKe media which contains material on fire disaster mitigation to train CrTS in early childhood. The reliability coefficient in each class showed the lowest score of 88.3% in Class B, while the highest score appeared in Class C at 90.8%, which means that the implementation of GaMaKe media meets the criteria of being very practical and reliable.

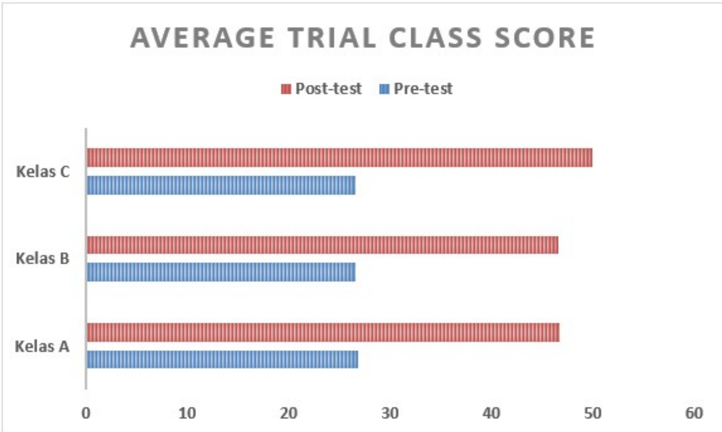
GaMaKe Media Effectiveness Results

GaMaKe media was tested in the field in classes A, B, and C to stimulate CrTS in early childhood. The achievement of CrTS indicators can be seen from individual achievements and class averages. The implementation of this field trial involved teachers in conducting learning using GaMaKe media which was previously trained by researchers. CrTS data analysis is presented in Table 11.

Table 11. Field Trial Results

Capaian		**Class A**		**Class B**		**Class C**	
		Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Lowest Value		23	43	24	44	23	47
Highest Value		31	50	29	49	33	54
Average Value		26,85	46,71	26,57	46,57	26,6	49,86
Total		18	18	18	18	18	18
Average		0,53		0,57		0,62	
N-Gain		Currently		Currently		Currently	

The data in Table 11 shows that the lowest average pre-test score was in class C, which was 26.6, and the highest score was in class A, which was 26.85. The results of the calculation of the highest average post-test score were in class C with a score of 49.86, while the lowest score was in class B with a score of 46.57. The achievement of N-Gain values in classes A, B, and C is categorized as moderate with the highest score achieved in class C at 0.62, while the lowest was in class A at 0.53. The average pre-test and post-test score achievement in all trial classes is presented in Graph 1.



Graph 1. Comparison of Average Scores of Trial Classes

Graph 1 shows that the average score of the pre-test and post-test results in class C showed the most significant increase compared to classes A and B, namely the difference in value reached 19.86. Achievement of class A score with a difference of 20 points in the pre-test and post-test results, meanwhile, class B achieved a difference of 23.26, so the increase was not much different.

Table 12. Calculation of N-Gain Value of CtTS Indicator

Indicator CtTS	Class	Limited Trial at TK Muslimat NU 124 Al Akhsan Average N-Gain	Category
Flexibility	A	0,62	Currently
	B	0,69	Currently
	C	0,68	Currently
Fluency	A	0,54	Currently
	B	0,52	Currently
	C	0,55	Currently
Originality	A	0,49	Currently
	B	0,40	Currently
	C	0,52	Currently
Elaboration	A	0,44	Currently
	B	0,48	Currently
	C	0,50	Currently

Table 12 shows that the average N-Gain achievement for each CrTS indicator in the trial class ranged from 0.40 to 0.69, which is categorized as moderate for all CrTS indicators. Achievements in each indicator show an increase in each CrTS indicator. The data also shows that the application of GaMaKe media has had a significant impact on increasing CrTS indicators during field trials. The results of the t-test (Paired Sample T-test) can be seen in Table 13.

Table 13. Paired Sample T-test Results

Class	**Field Trial Results**						
	Paired t-test, = 5%						
	N	**Mean**	**Std. Deviation**	**Std. error mean**	**t**	**df**	**Sig. (2-tailed)**
A	18	-27,158	3,149	0,723	-37,589	17	,000
B	18	-26,895	1,969	0,452	-59,537	17	,000
C	18	-29,243	3,784	0,759	-40,282	17	,000

The conclusion from the results of the t-test (Paired Sample T-test) shows that there is a difference between the pre-test and post-test scores on the CrTS indicator. The average post-test score was higher than the pre-test score, meaning there was an increase in the CrTS indicator score after being given GaMaKe media in the field trial class.

3.2 Discussion

The results of the research on the validity of GaMaKe media show that the results of the validation of the GaMaKe media material show an average score of 4.00, which is categorized as very valid. The average score of the validation results of the GaMaKe media components was 3.89, fulfilling the very valid category and its reliability fulfilled the average score of .92, fulfilling the very reliable category. GaMaKe media was developed in accordance with the CrTS indicators including Flexibility, Fluency, Elaboration, and Originality to assess the quality of the material and appearance of GaMaKe media. This media is given to children using the role play method on fire disaster mitigation material. This activity makes it possible for children to apply fire disaster mitigation material directly in the classroom. The results of this analysis are supported by Piaget's theory which explains that the presence of media is a concrete manifestation of what is learned (Huitt and Hummel, 2003), this means that GaMaKe media is a solution for providing disaster mitigation materials. Apart from being a concrete form of delivering the material being taught, media is also a bridge for teachers to help the learning process become more meaningful (Rachman et al., 2024).

The results of the data analysis on the implementation of learning in the trial class meet the criteria for being very practical for the learning carried out, meanwhile, the classroom atmosphere achieved an average score of 3.7 and time allocation management with an average score of 3.43, so both meet the criteria of being very practical. Teachers have conducted learning using GaMaKe media which contains material on fire disaster mitigation to train CrTS in early childhood. The reliability coefficient in each class showed the lowest score of 88.3% in Class B, meanwhile, the highest score appeared in Class C at 90.8%, which means that the implementation of GaMaKe media meets the criteria of being very practical and reliable. Practical learning media can certainly support more effective and meaningful learning quality (Afroogh et al., 2024.

This shows that GaMaKe media can be easily accessed by children in class. After working on the GaMaKe media, the teacher then applies the role play method to support children's understanding of fire disasters using direct practice as summarized in Figure 1. This finding supports previous research which states that the existence of media is very helpful for teachers in providing disaster mitigation material in a concrete and enjoyable way (Pranoto et al., 2023) (Maulida et al., 2023) (Gokmenoglu et al., 2023).

The practicality results of the GaMaKe media showed the lowest average pre-test score in class C at 26.6 and the highest score in class A at 26.85. The highest average post-test score calculation results were in class C with a score of 49.86, while the lowest value in class B was 46.57. The achievement of N-Gain values in classes A, B, and C is categorized as moderate with the highest score achieved in class C at 0.62, while the lowest in class A is 0.53. The description is presented in Table 12. These results support previous research which also shows that the use of media can influence the implementation of learning in the classroom (Fauzi et al., 2021) (Bossio et al., 2022) (Istyadji et al., 2022) (Lubis et al., 2023). Other previous research also shows that the use of digital media can train children's creative thinking (Tabieh et al., 2021; Song & Cai, 2024; Ningrum et al., 2024).

The results of the GaMaKe media effectiveness test can be seen in the average N-Gain achievement for each CrTS indicator in the trial class ranging from 0.40 to 0.69, which is categorized as moderate for all CrTS indicators. Achievements in each indicator show an increase in each CrTS indicator. The data also shows that the implementation of GaMaKe media has had a significant impact on increasing CrTS indicators during the trial. The conclusion from the results of the t-test (Paired Sample T-test) shows that there is a difference between the pre-test and post-test scores on the CrTS indicator. The average post-test score was higher than the pre-test score, meaning there was an increase in the CrTS indicator score after being given GaMaKe media in the field trial class. These results are presented in the descriptions of Tables 12, 13, and 14. These results support previous research which also shows that effective media can provide meaningful learning and the material is conveyed well to children (Ningrum et al., 2024) (Aruru et al., 2021) (Farcas et al., 2021) (Tkacová et al., 2022) (Daniel et al., 2025). The findings of this study can be recommendations for future research to enrich other disaster mitigation materials to provide stimulation for children's creative thinking supported by ongoing training for teachers in providing creative learning.

CONCLUCION

This research analysis concludes that the GaMaKe media is declared very valid and reliable so that a trial can be carried out to measure the CrTS indicators. The practical results show that GaMake media can be applied in the trial class and does not experience any significant obstacles. The effectiveness of GaMaKe media obtained an N-Gain score in the moderate category and there was a difference in the pretest-posttest scores for achieving the CrTS indicator so that it met the effective category. This research has an impact on improving CrTS in early childhood using interactive GaMaKe media in collaboration with the fun role play method. This GaMaKe media uses various visual images to understand fire disaster mitigation material which can stimulate CrTS indicators in early childhood. Future research requires awareness and ongoing training for teachers to implement GaMaKe media and enrich other disaster mitigation materials that frequently occur. In addition, it is necessary to develop GaMaKe media using augmented reality or metaverse technology.

AUTHOR CONTRIBUTION STATEMENT

M.A.N contributed to the problem analysis and research methodology conducted in this study. A.R conducted an analysis of the research results and provided reference reinforcement with a strong theoretical framework. M.D.W assisted in developing the discussion analysis and research implications in this article. K.R.A helped to translate and proofread so that the article writing has clear readability such as spelling, punctuation, and format. All authors contributed to compiling this research article.

DECLARATION

The authors of this study state that they have NOT affiliation with or involvement in anyorganization or entity with any financial interest (such as honoraria; educational grants; participationin the speaker's bureau; membership, employment, consulting, stock ownership, or other equityinterests; and expert testimony or patent licensing arrangements), or non-financial interests (suchas personal or professional relationships, affiliations, knowledge or belief) in the subject matter ormaterial discussed in this manuscript.

DATA AVAILABILITY

The research team would like to thank all respondents involved in this research project.

ACKNOWLEDGMENT

The research team would like to thank all respondents involved in this research project.

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