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Development of an Android Educational Game Magic Square -Megaforce Assisted to Improve Students' Creative Thinking Skills

Pengembangan *Game* Edukasi Android *Magic Square -Megaforce* untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa

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Abstract

The development of educational games is very relevant to learning activities in schools today. This research developed the Android educational game Magic Square – Megaforce to be valid, practical, and effective in improving students' creative thinking skills. This research is a development research with a 4-D model. The validity of educational games reached a high category with a correlation coefficient value of 0.95. This educational game is also declared practical with an average learning implementation of 100%. The effectiveness of this educational game was assessed based on classical learning completeness of 85.7%, student learning activities of 80%, and student response questionnaires of 85.5%, all of which were in the Good category. Educational game design can still be refined for further research so that it is more varied.

Keywords*: Creative Thinking Ability; Educational Game; Unity Software.*

Abstrak

Pengembangan game edukasi sangat relevan dengan kegiatan pembelajaran di sekolah saat ini. Penelitian ini mengembangkan game edukasi Android Magic Square – Megaforce hingga valid, praktis, dan efektif meningkatkan kemampuan berpikir kreatif siswa. Penelitian ini merupakan penelitian pengembangan dengan model 4-D. Validitas game edukasi mencapai kategori tinggi dengan nilai koefisien korelasi 0,95. Game edukasi ini juga dinyatakan praktis dengan rata-rata keterlaksanaan pembelajaran sebesar 100%. Efektifitas game edukasi ini dinilai berdasarkan ketuntasan belajar klasikal sebesar 85,7%, aktivitas belajar siswa sebesar 80% dan angket respon siswa sebesar 85,5% yang semuanya berada pada kategori Baik. Desain game edukasi masih dapat disempurnakan untuk penelitian selanjutnya sehingga lebih variatif.

Keywords*: Game Edukasi; Kemampuan Berpikir Kreatif; Software Unity.*

Introduction

Maths is one of the most widely studied subjects in the world. As a discipline that plays an important role in life, its existence is very close to the world of education. Mathematics is also important as a science tool and guide for forming mindsets and attitudes[1]. A good mindset in students can be seen from understanding information and communication. To understand information and communication that is always growing rapidly, it is necessary to master mathematics from an early age[2]. Therefore, adjusting to the current education system is necessary to hone mastery of mathematics early on.

The current education system applies the Pancasila learner profile as a form of translation of national education goals. One of the dimensions of the Pancasila learner profile is creativity. Based on the Decree of the Head of the Education Standards, Curriculum and Assessment Agency of the Ministry of Education and Culture number 009/H/KR/2022, a creative learner can modify and produce something original, meaningful, useful, and impactful[3]. Meanwhile, creativity can be seen as the result of creative thinking. So, creative thinking greatly affects a person's creativity[4].

A person can think creatively if they fulfill several criteria after The Torrance Tests of Creative Thinking (TTCT): fluency, flexibility, and novelty. Fluency in children and adults can be seen from the various ideas that arise when responding to something (command). At the same time, flexibility refers to the changing responses to a command. The novelty lies in the originality of ideas or novelty individuals find in responding to commands[5]. So, it can be said that originality is part of novelty.

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[1] Sukanto Sukandar Madio, "Model Pembelajaran Generatif Dalam Upaya Meningkatkan Hasil Belajar Matematika" 1 (2012): 29–34.

[2] Siti Rodiah and Veny Andika Triyana, "Analisis Kemampuan Penalaran Matematis Siswa Kelas IX MTS Pada Materi Sistem Persamaan Linear Dua Variabel Berdasarkan Gender," *Jurnal Kajian Pembelajaran Matematika* 3, no. 1 (2019): 1–8.

[3] KemendikbudristekNo.09, *Keputusan Kepala Badan Standar, Kurikulum, Dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, Riset, Dan Teknologi Nomor 009/H/KR/2022 Tentang Dimensi, Elemen, Dan Sebelemen Profil Pelajar Pancasila Pada Kurikulum Merdeka*, *Kemendikbudristek BSKAP RI*, 2022.

[4] Tatag Yuli Eko Siswono, "Level of Student's Creative Thinking in Classroom Mathematics," *Educational Research and Reviews* 6, no. 7 (2011).

[5] Edward A. Silver, "Kreativität Fördern Durch Einen Unterricht, Der Reichist and Situationen Des Mathematischen Problemlösens Und Aufgabenerfindens," *ZDM - International Journal on Mathematics Education* 29, no. 3 (1997): 75–80, https://doi.org/10.1007/s11858-997-0003-x; Siswono, "Level of Student's Creative Thinking in Classroom Mathematics."

Students' creative thinking skills should be improved by maximizing existing technology. This is because using technology in learning improves students' creative thinking skills better than just using expository[6]. So that mathematics learning must be delivered as well and as interesting as possible. For this reason, innovation in learning is needed, which is expected to help improve students' creative thinking skills, especially in mathematics subjects where, in this case, the role of technology is needed.

One of the important phases in technological development is the emergence of the Industrial Revolution 4.0, which was marked by the birth of Artificial Intelligence (AI) in various product formations that can work like optimized human brain functions[7]. In addition, the Industrial Revolution 4.0 emphasizes the pattern of digital economy, artificial intelligence, big data, robotics, and so on, or the phenomenon of disruptive innovation[8]. Facing these challenges, the learning system in Indonesia is also required to change. One way is learning while playing, where the context of learning this time is playing educational games.

After the researcher conducted observations in the form of interviews with a mathematics teacher at one of the junior high schools in Jember, the researcher found out that in mathematics learning carried out so far in the junior high school using an expository learning model, in this learning the material is only delivered by the teacher directly. The teacher provides practice problems and solutions. In expository learning, teaching activities are centered on the teacher[9]. In learning, students are rarely allowed to interact and appreciate objects around them that can function as learning resources, especially by utilizing existing technology.

Research on learning technology, especially educational games in learning mathematics, has been conducted several times. The results of these studies show a positive impact of using educational games. For example, research on the Maths RPG Game concluded that the educational game is interesting, fun, and can educate its users[10]. However, interesting and fun are still not enough for learning mathematics today. Therefore, improving students' thinking skills is necessary, which can also be facilitated through

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[6] Wafik Khoiri, Rochmad Rochmad, and Adi Nur Cahyono, "Multimedia-assisted Problem Based Learning in Mathematics Learning to Improve Creative Thinking Ability," *Unnes Journal of Mathematics Education* 2, no. 1 (March 21, 2013), 120.

[7] K. Schwab, "The Fourth Industrial Revolution. Cologny/Geneva: World Economic Forum.," 2016.

[8] Yulia Yulia, Neni Marlina BR Purba, and Januardi Nasir, "Aplikasi Game Edukasi Matematika Berbasis Android," *Indonesian Journal of Computer Science* 8, no. 2 (2019): 101–12, https://doi.org/10.33022/ijcs.v8i2.196.

[9] Dimyati and Mudjiono, *Teori Belajar Dan Pembelajaran* (Jakarta: Rineka, 2006).

[10] Surya Amami Pramuditya, M. Subali Noto, Dede Syaefullah, *"Maths Educational Game".* EduMa. Vol. 6, No. 1, July 2017, ISSN 2086-3918, pp. 77-78.

educational games. It is the enhancement of creative thinking skills that is included in this study.

Based on this description, the author wants to develop an Android-based educational game to improve students' creative thinking skills. The game was built with the help of Unity software. Unity was chosen because it supports 25 leading platforms, including mobile platforms. In April 2012, Unity had 1 million developers. In May of the same year, a survey by Game Developer revealed that about 53% of mobile game developers use Unity[11]. With this research, it is hoped that it will increase students' interest in learning and can be a tool for teachers as facilitators and references for students to learn.

Methods

The type of research used in this study is Research and Development (R&D), with the development model referring to the 4D model (the four D model). The development stages of the four D models are defined, designed, developed, and disseminated.

The first stage is defined, which aims to determine the needs in learning by analyzing the objectives and paying attention to the limitations of the material. This stage consists of a preliminary analysis of the end using observation and analyzing previous research that is still relevant. Then, media analysis is used to determine whether educational games are needed and what updates educational games should have if there are already similar ones. Then, learning objectives are formulated to determine the purpose of preparing the learning media design.

The design stage aims to design educational games. This stage consists of preparing initial and final tests to determine the level of development of student's creative thinking skills, media selection, which is carried out to determine the right media to present learning materials, then format selection, which includes designing content, selecting the type of educational game and platform to be used, and finally the initial media design that produces draft I accompanied by research instruments, including validation sheets and user response questionnaires.

The development stage consists of expert validation to determine the feasibility of mathematics educational games to be applied to learning according to the objectives to be achieved and trials to measure the effectiveness and practicality of educational games that have been made. This stage was carried out to produce a draft II educational game. Draft II is an

[11] John Haas, "A History of the Unity Game Engine An Interactive Qualifying Project Submitted to the Faculty of Worcester Polytechnic Institute in Partial Fulfillment of the Requirements for Graduation," 2014, 44.

educational game revised based on expert input and data obtained from trial results.

The instruments in this study include validation sheets, creative thinking ability tests, and a questionnaire response to the use of media by students. The validation sheet contains 3 aspects, which include format aspects, content aspects, and language aspects. Determination of validation begins with calculating the correlation coefficient value, then said to be valid if the validation criteria show a minimum value of high. The validity coefficient interpretation category can be seen in Table 1.

Table 1. Validity Coefficient Interpretation Categories

Magnitude α	**Interpretation**
$0.8 < \alpha \mid \leq 1$	Very High
$0.6 < \alpha \mid \leq 0.8$	High
$0.4 < \alpha \mid \leq 0.6$	Medium
$0.2 < \alpha \mid \leq 0.4$	Low
$0 < \alpha \mid \leq 0.2$	Very Low

After the educational game is valid, it will be tested to obtain data to measure practicality and effectiveness. Educational game practicality data represents the implementation of an educational game that has been developed. The data on the practicality of this educational game is obtained from the observation sheet, namely from the observation of the implementation of learning. The following are the criteria for the average percentage of observation results presented in Table 2.

Table 2. Practicality Criteria Educational *Games*

Score	**Conclusion**
$90\% \leq SR \leq 100\%$	Very good
$80\% \leq SR < 90\%$	Good
$70\% \leq SR < 80\%$	Good enough
$40\% \leq SR < 70\%$	Less good
$0\% \leq SR < 40\%$	Very poor

Furthermore, there are three indicators to measure the device's effectiveness: learning outcome test data, student activity observation data, and student response questionnaire data. The percentage of classical completeness can measure the analysis of the learning outcomes test. If $\geq 80\%$ the total number of students have completed it, it is classically complete. If $< 80\%$ the total number of students have completed, it is categorized as not

classically complete. Next is the percentage analysis of student activity observation results, divided into 5 intervals in Table 3.

Table 3. Data Criteria for Student Observation Results

Score	Conclusion
$90\% \leq P \leq 100\%$	Very Active
$80\% \leq P < 90\%$	On
$70\% \leq P < 80\%$	Active Enough
$40\% \leq P < 70\%$	Less Active
$0\% \leq P < 40\%$	Inactive

Student response questionnaires are used to determine the third requirement for the effectiveness of educational games. In addition, the data obtained from the questionnaire can also strengthen the observation results. The results of student responses to educational games can be seen from the percentage of responses obtained. The percentage category of the media usage questionnaire can be seen in Table 4.

Table 4. Category Percentage of Media Usage Questionnaire

Category Percentage	Value
Very good	$P > 95\ \%$
Good	$80\ \% < P \leq 95\ \%$
Simply	$65\ \% < P \leq 80\ \%$
Less good	$50\ \% < P \leq 65\ \%$
Very less	$P \leq 50\ \%$

The last stage is dissemination. This stage is carried out after the educational game meets the valid, effective, and practical criteria and has been tested on students who show that this educational game can improve creative thinking skills. Dissemination is done through the Google Play Store because it will make it easier for users to receive installations on their respective devices without being limited by distance and time.

Results and Discussion

The results and discussion of the research are presented by the 4D (four D) research model, namely:

1. Define stage

At this stage, 3 activities were identified: the initial and final analysis, media analysis, and goal formulation. See Table 5.

Table 5. Results of the Defining Stage

No.	Activities	Identification	Results
1	End Start Analysis	Students' mathematics scores, especially on whole number operations, are still poor because students are less interested in learning mathematics with the expository method.	Developing learning media that can improve students' understanding of whole numbers and can attract students' attention to learning mathematics.
2	Media Analysis	Every student already has an Android smartphone that can be brought to school but has never been utilized in learning. On the other hand, Unity software can be used to create Android-based learning media.	Developing Android smartphone-based learning media assisted by Unity software
3	Formulation of Objectives	Students' creative thinking skills are still relatively low. In addition, many students are less interested in learning mathematics with the expository method.	Developing learning media that can improve creative thinking skills and be interesting for students so that their interest in learning mathematics increases.

So far, students' creative thinking skills are still relatively low, so these abilities must be improved to develop creativity in thinking and behavior[12]. Interviews with mathematics teachers explained that students get poor scores in PPDB test scores, especially in mathematics. Another problem is the lack of interest in learning mathematics. Students are now more interested in

[12] Alberth Supriyanto Manurung, Abdul Halim, and Ainur Rosyid, "Pengaruh Kemampuan Berpikir Kreatif Untuk Meningkatkan Hasil Belajar Matematika Di Sekolah Dasar," *Jurnal Basicedu* 4, no. 4 (2020), https://doi.org/10.31004/basicedu.v4i4.544.

technology than reading books[13]. Students use package books only obtained from borrowing from the school library when students study at home, it isn't easy to obtain reference books as learning materials.[14]

Every student already has an Android smartphone and may be brought to school but has never utilized it in learning. There are still many students who use smartphones only to play[15]. In addition, learning has taken place so far only using book media and teaching aids. Electronic media such as PCs (Personal Computers) or smartphones are still not used optimally, especially in learning. The development carried out by researchers uses Unity software. Unity is software that creates 3-dimensional and 2-dimensional games on platforms such as Personal Computers (PCs), Android/iOS, PlayStation, WebGL, etc. Unity can be applied using the C# or Java programming language and combined with other supporting software such as graphic design software such as Corel Draw to produce interesting and practical games[16].

From this background and problems, including relevant previous research, educational games are needed by students not only in terms of material but also in terms of interest and effectiveness for users, especially students[1718]. Interesting educational games are needed to facilitate students in learning activities, so it is hoped that students can improve their creative thinking skills.

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[13] Suci Wulandari, "Media Pembelajaran Interaktif Untuk Meningkatkan Minat Siswa Belajar Matematika Di SMP 1 Bukit Sundi," *Indonesian Journal of Technology, Informatics and Science (IJTIS)* 1, no. 2 (2020), https://doi.org/10.24176/ijtis.v1i2.4891.

[14] Ida Ambarwati and Rochmawati, "Buku Ajar Berbasis Contextual Teaching and Learning (CTL) Pada Mata Pelajaran Komputer Akuntansi Accurate," *Jurnal Mimbar Ilmu* 25, no. 3 (2020).

[15] Mirza Alvira, "Studi Deskripsi: Perilaku Adiksi HP (Gadget Addiction) Peserta Didik di SMP Negeri 37 Surabaya," *Bikotetik (Bimbingan Dan Konseling Teori Dan Praktik)* 5, no. 1 (2021), https://doi.org/10.26740/bikotetik.v5n1.p43-48.

[16] Lourent S. Mongi, Arie S.M. Lumenta, and Alwin M. Sambul, "Rancang Bangun Game Adventure of Unsrat Menggunakan Game Engine Unity," *Jurnal Teknik Informatika* 13, no. 1 (2018), https://doi.org/10.35793/jti.13.1.2018.20191.

[17] Clara Ika Sari Budhayanti and Julius Bata, "Pengembangan Game Edukasi Untuk Materi Bangun Datar Menggunakan Lintasan Belajar Geometri," *Jurnal Muara Ilmu Sosial, Humaniora, Dan Seni* 5, no. 1 (2021), https://doi.org/10.24912/jmishumsen.v5i1.9477.2021.

[18] Hayu Ika Anggraini, Nurhayati Nurhayati, and Shirly Rizki Kusumaningrum, "Penerapan Media Pembelajaran Game Matematika Berbasis Hots Dengan Metode Digital Game Based Learning (DGBL) Di Sekolah Dasar," *Jurnal Pendidikan Indonesia* 2, no. 11 (2021), https://doi.org/10.36418/japendi.v2i11.356.

2. Design Stage

The results of the design stage can be seen in Table 6.

Table 6. Results of the Design Stage

No.	Activities	Results
1	Test Preparation	Initial and final tests that lead to 3 indicators of creative thinking ability
2	Media Selection	Educational *games are* used to improve students' creative thinking skills
3	Format Selection	Educational *games* that are *puzzle games are* taken from the *magic square* game and use the .apk format or *Android games.*
4	Initial Design of Educational *Game*	*Magic Square - Megaforce Android-based* educational *game* with *Unity software* (draft I) accompanied by research instruments, including validation sheets and user response questionnaires.

The preparation of tests developed in the study consisted of the preparation of initial tests and final tests to measure the effect of the study[19]. In preparation for the test, researchers are guided by the indicators of creative thinking, which are 3, namely fluency, flexibility, and novelty[20], with the test that will be tested, namely essay questions that have led to the 3 indicators of creative thinking. In the initial and final tests, students will solve magic square problems using integer operations with many solutions (fluency), diverse or varied solutions (flexibility), and a unique pattern of final results from other students (novelty).

The selection of media is based on the results of the review of the initial analysis. Researchers chose mathematics educational games on Android because games attract students to improve their creative thinking skills and make mathematics learning interesting, similar to previous research on the

[19] Dwiki Prasetya Subakti, Jefri Marzal, and M Haris Effendi Hsb, "Pengembangan E-LKPD Berkarakteristik Budaya Jambi Menggunakan Model Discovery Learning Berbasis STEM Untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis," *Jurnal Cendekia: Jurnal Pendidikan Matematika* 05, no. 02 (2021).

[20] Masita Ulil Syahara and Erna Puji Astutik, "Analisis Berpikir Kreatif Siswa Dalam Menyelesaikan Masalah SPLDV Ditinjau Dari Kemampuan Matematika," *Mosharafa: Jurnal Pendidikan Matematika* 10, no. 2 (2021), https://doi.org/10.31980/mosharafa.v10i2.892.

effect of educational games on creative thinking skills[21][22][23]. The development of the educational game "Magic Square - Megaforce" on Android was carried out by researchers using Unity software independently. The researcher compiled the game concept by adjusting the students' creative thinking indicators consisting of 4 matrix sizes where each matrix size will adjust the creative thinking indicators. The selection of mathematics educational games on Android utilizes the availability of gadgets owned by students to be used optimally as a tool for learning.

The Android game format was developed in the form of a .apk format. The selection of this format is based on previous research, which says that most students more often use games with Android format than games with .exe format owned by Windows PC. Players or students can be downloaded on the Google Play store so that students can access and install the game easily. The shape of the game display can be seen in Figure 1.

Image 1. Educational Game View

The initial design of the learning media for mathematics educational games is to determine how the game will work according to the available creative thinking indicators. The game display is made with a design that is as attractive as possible so that players are more comfortable in playing the game. Coupled with the backsound that automatically plays when the player opens the game. Then, provided 4 matrix sizes containing 3 levels each. The initial design will produce a draft I, which is then validated at the development stage.

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[21] Asri Muslim Sanusi, Ari Septian, and Sarah Inayah, "Kemampuan Berpikir Kreatif Matematis Dengan Menggunakan Education Game Berbantuan Android Pada Barisan Dan Deret," *Mosharafa: Jurnal Pendidikan Matematika* 9, no. 3 (2020), https://doi.org/10.31980/mosharafa.v9i3.866.

[22] Debby Arisandy, Jefri Marzal, and Program Studi Pendidikan Matematika, "Pengembangan Game Edukasi Menggunakan Software Construct 2 Berbantuan Phet Simulation Berorientasi Pada Kemampuan Berpikir Kreatif Siswa" 05, no. 0 (2021): 3038–52.

[23] Fauzi Khoirul Mahfi, Jefri Marzal, and Saharudin Saharudin, "Pengembangan Game Edutainment Berbasis Smartphone Sebagai Media Pembelajaran Berorientasi Pada Kemampuan Berpikir Kreatif," *Jurnal Pendidikan Matematika* 11, no. 1 (2020), https://doi.org/10.36709/jpm.v11i1.9901.

3. Develop stage

The results obtained at this development stage are educational games based on Android Magic Square - Megaforce assisted by Unity software (draft II), which have passed the validation and trial process.

Educational game validation aims to produce a valid and feasible educational game to be trialed on the test site. The media can be declared valid if the average assessment data obtained from all aspects listed on the validation sheet from the validator shows an average value greater than 0.6 following the media validity interpretation criteria[24]. Suppose the value given by the validator does not meet the validity interpretation criteria. In that case, the game is first revised according to the validator's suggestions so that the resulting valid draft II can be tested on students or users[25][26]. The educational game revision process can be seen in Table 7.

Table 7. Educational *Game* Revision Process

Before Revision	**After Revision**
	
No hint button	The hint button is placed at the beginning when you first open the app. The button is given a visible color.
	
The numbers used in the test questions, and media should be	The numbers used in the test questions and media have added

[24] Sumarna Supranata, *Analisis Validitas, Reliabilitas Dan Interpretasi Hasil Tes* (Bandung: PT Remaja Rosdakarya, 2005).

[25] Syafitri Wulandari, Yudi Darma, and Utin Desy Susiaty, "Pengembangan Modul Berbasis Pendekatan Realistic Mathematics Education (RME) Terhadap Pemahaman Konsep," *Jurnal Pendidikan Informatika dan Sains* 8, no. 1 (2019), https://doi.org/10.31571/saintek.v8i1.1179.

[26] Alawiyah Mahfudhah, Dewi Hamidah, and Eka Resti Wulan, "Lectora Inspire Interactive E-Module with a Realistic Approach to Facilitate Understanding of Mathematical Concepts" 10, no. 1 (2022): 35–60.

Before Revision	After Revision
added with negative numbers. To make students more creative in performing whole number operations.	negative numbers so that students are more creative in performing whole number operations.

After revising the educational game until it is declared valid, it is tested to determine the level of practicality and effectiveness. To determine the practicality of an educational game, it is necessary to analyze the implementation of learning in the classroom and the observer's assessment of the implementation of learning using the Magic Square-Megaforce Android educational game. Observations were made when researchers carried out learning in the classroom. 2 observers observed researchers conducting research or learning trials.

The trial was conducted in one meeting with a time allocation of 3 × 40 minutes. The observations used were syntax observation, social system, and reaction and management principles. The observation technique of learning implementation carried out in this study is using Likert scale questions 1- 4. Observers are asked to give a tick (✓) in the assessment scale column. The observation scores given by the observers were then recapitulated and analyzed. The scores of the learning implementation observation results are presented in Table 8.

Table 8. Recapitulation of Learning Implementation Observation Scores

No.	Assessment Aspect	Observer 1	Observer 2	Average (I_i)
1	Syntax			
	1. The level of implementation of all stages of learning	4	4	4
	2. Implementation of the sequence of learning activities based on the Magic Square-Megaforce Android educational game oriented towards creative thinking skills	4	4	4
	Average score of aspect I (A_I)			4
2	Social System			
	1. The degree of implementation of the desired situation (atmosphere) (downloading the educational game, paying attention to the reference presentation, playing the educational game, analyzing the patterns of each level)	4	4	4

No.	Assessment Aspect	Observer 1	Observer 2	Average (I_i)
	2. Implementation level of interaction in learning (student-student and student-teacher)	4	4	4
	3. Implementation of teacher behavior embodying the principles and concepts of creative thinking in the Magic Square-Megaforce Android educational game	4	4	4
	Average score of aspect II (A_{II})			4
3	Reaction and Management Principles			
	1. Teacher's implementation in accommodating and providing opportunities for students to ask questions, express opinions, and give responses	4	4	4
	2. The level of implementation of teacher behavior in assisting, instructions, and guiding students in learning	4	4	4
	3. The level of implementation of teacher behavior in motivating learning	4	4	4
	4. Implementation level of teacher behavior involving students actively in learning	4	4	4
	5. The level of teacher implementation in facilitating student learning	4	4	4
	Average score of aspect III (A_{III})			4
	The average score of all aspects			4
	Percentage of overall aspect score			100%

Based on the recapitulation of the learning implementation observation results in Table 8, it can be described as follows.

a. In the syntax aspect, indicator 1 gets an average score (I_1) of 4, and indicator 2 gets an average score (I_2) of 4, so the average score for the syntax aspect (A_I) is 4.
b. In the social system aspect, indicator 1 gets an average score (I_1) of 4, indicator 2 gets an average score (I_2) of 4, and indicator 3 gets an average score (I_3) of 4, so the average score for the social system aspect (A_{II}) is 4.
c. In the aspect of reaction and management principles, indicator 1 gets an average value (I_1) of 4, indicator 2 gets an average value (I_2) of 4, indicator 3 gets an average value (I_3) of 4, indicator 4 gets an average value (I_4) of 4, and indicator 5 gets an average value (I_5) of 4, so the average value for the aspect of reaction and management principles (A_{III}) is 4.

From all aspects of learning implementation, the overall average score (*SR*) of learning implementation using the Magic Square-Megaforce Android educational game *was* 4, with a percentage of 100%. Based on the criteria of practicality, the overall average score of the implementation of learning is in the range of $90\% \leq SR \leq 100\%$, so that the implementation of learning is in the very good category.

To measure the effectiveness of educational games, 3 indicators are needed, namely student learning outcomes, student activity observation results, and student response results. Student learning outcomes are obtained through posttest scores in the form of student final tests after participating in learning activities using the Magic Square-Megaforce Android educational game developed by researchers to determine student learning completeness. The research subjects were 14 students. Based on the post-test results, it was found that as many as 12 students (85.7%) had scores above the KKM, which means they were classically complete. The product analysis results of the developed learning tools show that the developed products are said to be effective.

Furthermore, based on the results of observations of student activity, the observations used are preliminary, observations of core activities, and closing observations. The student activity observation technique in this study uses Likert scale questions 1- 4. The observer is asked to give a tick (✓) in the rating scale column. The observation score given by the observer was then recapitulated and analyzed. Student activity observation scores are presented in Table 9.

Table 9. Recapitulation of Student Activity Observation Scores

No.	Assessment Aspect	Observer 1	Observer 2	Average (I_i)
1	Introduction			
	1. Students have attention and a sense of motivation toward the presentation of learning objectives	3	3	3
	2. Students listen to the teacher's explanation regarding the study material to be learned	3	3	3
	Average score of aspect I (A_I)			3
2	Core Activities			
	1. Students download and install educational games	4	3	3,5
	2. Students pay attention and are motivated to the reference presentation	3	3	3
	3. Students pay attention to how to play the educational game	4	3	3,5

No.	Assessment Aspect	Observer 1	Observer 2	Average (I_i)
	4. Students play the educational game with enthusiasm	4	4	4
	5. Students analyze the pattern of each level of the educational game	4	4	4
	6. Students took the pretest and posttest with enthusiasm	4	3	3,5
	Average score of aspect II (A_{II})			3,58
3	Cover			
	1. Students can make conclusions from learning activities	3	3	3
	Average score of aspect III (A_{III})			3
	An average score in all aspects			3,2
	Percentage of overall aspect score			80%

Based on the recapitulation of student activity observation results in Table 9, it can be described as follows.

a. In the introduction aspect, indicator 1 gets an average score (I_1) of 3, and indicator 2 gets an average score (I_2) of 3, so the average score for the introduction aspect (A_I) is 3.
b. In the aspect of core activities, indicator 1 received an average score (I_1) of 3.5; indicator 2 received an average score (I_2) of 3; indicator 3 received an average score (I_3) of 3.5; indicator 4 received an average score (I_4) of 4; indicator 5 received an average score (I_5) of 4; and indicator 6 received an average score (I_6) of 3.5; so the average score for the aspect of core activities (A_{II}) was 3.58.
c. In the closing aspect, indicator 1 gets an average score (I_1) of 3, so the average score for the closing aspect (A_{III}) is 3.

From all aspects of student activity, the overall average score of student activity observations was 3.2, with a percentage of 80%. Based on the effectiveness criteria with a percentage of activeness, the average score of the observation results is in the range of $80\% \le P \le 90\%$, so that student activity is in the active category and shows that the product that has been developed is said to be effective.

Followed by analyzing the results of student responses. Student questionnaire sheets were distributed in hard file form. Fourteen students filled out the questionnaire. Based on the response of one of the students in the class, the educational game used makes students who learn feel more interested and happy to learn the material provided. Students feel interested

and it is easy to use. It is in line with relevant previous research[27]. The media used is easy to operate anywhere offline with their respective smartphones. Other research also states that the advantages of using game-based learning media can create learning from fun, motivation, convenience, and interest by containing theory, example problems, exercises, and tests[28][29]. The criteria in the questionnaire consist of 4 criteria. The criteria consist of "I can start opening the "Magic Square" educational game easily", "I feel happy learning with the "Magic Square" educational game", "I don't feel bored learning with the "Magic Square" educational game", and "I am motivated to learn mathematics after using the "Magic Square" educational game."

Table 10: Student Response Results

Description	Indicators			
	I_1	I_2	I_3	I_4
Average result	3,64	3,64	3,42	3,21
Average total	3,43			
Percentage	85,75%			

From the average results above, a total average of 3.43 was obtained, and the percentage of student response questionnaires was 85.5%. This indicates that most students responded positively (good) to the learning and the Magic Square-Megaforce Android educational game presented. This means that the three requirements of an effective learning media have been fulfilled. Based on the overall data, it can be analyzed that the Magic Square-Megaforce Android educational game product developed is valid with several revisions. Then, the data taken during the product trial shows practical and effective criteria.

4. Disseminate or Spread Stage

This Magic Square - Megaforce educational game is intended for students who want to improve their creative thinking skills. This game will also focus more on students who lack interest in mathematics. It is expected that with this game, the ability to think creatively in mathematics can increase after conducting trials at SMP Muhammadiyah 1 Jember and knowing that the

[27] Untung Ali Miftahuddin, FNU Hobri, and Randi Pratama Murtikusuma, "Pengembangan Game Android Berbantuan Software Construct 2 Pada Materi Pola Bilangan," *Vygotsky*, no. 2 (2019), https://doi.org/10.30736/vj.v1i2.135.

[28] H. T. Wijaya, A. Fatahillah, and E. Oktavianingtyas, "Pengembangan Media Pembelajaran Berbasis Game Android Dalam Menghadapi Era Revolusi Industri 4. 0 (Development of Learning Media Based on Android Game in Dealing With Industrial Revolution Era 4 . 0).," 2018.

[29] Galih Agustinus Pujakusuma and . Dkk, "Game Incredible Math Berbasis Android Sebagai Media Pembelajaran Virtual Reality," *Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika (SNMPM)* 2, no. 1 (2018).

existence of this educational game helps students make SMP Muhammadiyah 1 Jember accept this product.

The distribution of this product is done officially through Google's application service provider, Google Playstore. This media is used because the Google Play store has guaranteed everything related to the game: licenses, compatibility with existing devices, security, access permissions, etc. This includes security from irresponsible parties. Users can also provide feedback or feedback to developers[30]. In addition, everyone can access the Google Play store for free through their Android device[31]. The direct address to get into this application can be accessed and downloaded in full through the following link: https://unej.id/Megaforce or scan the following QR Code:

Figure 2. QR Code for Magic Square - Megaforce Educational Game

Conclusion

This research produced an educational game that met the criteria of valid, practical, and effective. The validity of educational games reached a high category with a correlation coefficient value of 0.95. Practicality is evidenced by the average percentage of learning implementation of 100%, including in the very good category. Effective as evidenced by 85.7% of students completed classically, the average percentage of student activity was 80% in the active category, and the percentage of student response questionnaire was 85.5% in the good category. This research also affects students' creative thinking skills, as evidenced by classical learning completeness, student learning activities, and student response questionnaires which all of which were in the Good category.

[30] Anggita Eka Dewi Melania et al., "Analisis Keamanan Aplikasi Android Non Playstore Dengan Metode Digital Forensik Pendekatan Statis Dan Dinamis" 15, no. 2 (2021): 29–34.

[31] Asep Saeful Milak, Eka Wahyu Hidayat, and Aldy Putra Aldya, "Penerapan Artificial Intelligence Pada Non Player Character Menggunakan Algoritma Collision Avoidance System Dan Random Number Generator Pada Game 2D 'Balap Egrang,'" *Jurnal Teknologi Informasi Dan Ilmu Komputer* 7, no. 5 (2020), https://doi.org/10.25126/jtiik.2020711816.

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