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Digital-Based Logma Educational Game on Early Childhood Logic-Mathematics Intelligence

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ABSTRACT

This research aims to improve early childhood Logic-Mathematics Intelligence and create a valid and practical *Logma* Educational Game Media by using the ADDIE development research approach (analysis, design, development, implementation, and evaluation). The data collection procedures used documentation, interviews, questionnaires, and observations. Validity and practicality tests were used in the data analysis process. Data related to validity and practicality were obtained from questionnaire answers, which were then analyzed using a Likert scale. Based on the results of the study, the validity of material experts I is 82.2 very valid level, the material II 93.3 very valid category, and the media experts 96.6 very valid level. The practicality test of the *Logma* Educational Game based on the teacher response questionnaire 86.2 level is very practical, as well as a small-scale trial learner instrument questionnaire 96 declared very practical and a large-scale trial 93.1 declared very practical. The results of this study conclude that the digital-based Logma Educational Game to increase Logical-Mathematical Intelligence is declared valid, practical, and feasible to use in learning. The impact of the *Logma* Educational Game on technological progress is that it can be use as a means of learning mathematics that can help children understand the concept of logic-mathematics from an early age, so that when entering elementary school children no longer feel afraid to learn mathematics.

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1. INTRODUCTION

At this time the development of technology is accelerating. The development of gadget technology is also growing rapidly. Early childhood development is now surrounded by advances in technological sophistication. Games that often consume a lot of user time can also be utilized together with developed technology, depending on the level of use and amount of time. Children who become game addicts usually play games more often than they study. Playing games can have good or bad effects, if it is used briefly then it has a good effect. However, if it is used for a long duration and every day, it can hurt the user. Children who play games are more likely to acquire logical-mathematical intelligence, such as the ability to calculate, think logically, and solve problems (Ismet et al., 2022).

Rapidly developing technology affects various aspects of life. Technology is also very helpful in all fields, including education. The use of technology in the classroom will make learning more efficient. However, to improve the quality of education in the future, learning materials should also utilize these technological advancements (Praing & Talakua, 2023).

Based on the impact of technological advancements, games can be used as a learning tool to help children understand mathematical concepts early on, so that when they enter primary school, they will no longer be afraid of learning maths, and will even love maths. Since games are used for entertainment, learning through games can make learning fun for children, making them one of the most useful forms of interactive learning tools. Through games, children can play while learning, making the time spent more useful (Gunawan et al., 2022).

The most widely taught subject at all levels of education is maths. It is the foundation of all education and maths continues to be relevant to our daily lives through things like numbers and calculations (Arseven, 2015).). Humans are inseparable from mathematics all humans have intelligence that includes mathematics and problem-solving.

By the opinion of Gardner (Fitria & Fadlillah, 2023) humans have multiple intelligences or Multiple Intelligences where everyone must have all the intelligence, one of which is logic-mathematics. According to him, children who are gifted in maths and logic usually like counting games, classifying objects, asking questions, exploring, understanding cause-and-effect concepts, and various other activities. If you want children's logical-mathematical intelligence to increase, you need a medium that can hone this intelligence.

Children's logical-mathematical intelligence is still weak because the facts about how they learn these subjects in nursery school are still rudimentary (Tasliyah et al., 2020). Learning activities that are fun, efficient, interesting, and significant are essential for the development of logical-mathematical intelligence. All this will be achieved if teachers can understand children's learning characteristics and are supported by appropriate facilities and infrastructure. Therefore, by offering various activities and educational games, teachers and parents can enhance children's talents.

The utilization of technology-based learning tools for early childhood can foster creativity and effectiveness in learning (Kembuan et al., 2019). When compared to traditional forms of play, electronic-based play generally provides more benefits, including the ability to hold varied data through large storage capacity and user convenience. However, it is important for parents to carefully study and utilize electronic-based play tools for their children. Electronic games that do not require a lot of paper can be classified as environmentally friendly games (Julianti & Munastiwi, 2021).

In addition, with the various applications in Playstore, the main purpose of smartphones that be useful as communication and media tools has evolved into educational tools. Part of the operating system that smartphones use to execute certain commands is Android

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(Yustyalatifa et al., 2022). Of the various means, the suitable learning media used by parents and educators in improving logical-mathematical intelligence is the digital-based Logma Digital Educational Game. Besides being easily accessible, this game contains educational elements where when children play it, children will learn to solve a problem, think logically, understand basic mathematical concepts for early childhood, and understand the concept of cause and effect.

Literature Review

Logma Educational Game

A form of educational games called "digital educational games" are games that are played on computers, laptops, tablets, or smartphones. Educational games are designed to increase children's interest and desire to learn, provide them with new experiences during the learning process, and improve children's understanding of the subject matter being learned (Masykhur & Risnani, 2018).

Game-based learning (GBL) helps children improve their problem-solving skills and allows them to interpret society, nature, and the world around them through experience. Therefore, the use of games in education can be a potential solution as an interactive medium for learning and understanding (Saputri et al., 2018). Games that are expressly created to instruct players on a specific topic, help them understand and practice skills, and inspire them to play the game are known as educational games (Anastasiadis et al., 2018).

According to Rukmana, educational games have many benefits for education. One of the benefits is expanding children's knowledge on various topics, such as maths, language, science, and history. Utilizing digital tools can help children get involved in problem-solving, gain quick experience, and exist in a clear state. Given that children need digital educational games that are suitable for digital natives, it is important to utilize digital tools that are appropriate for them (Hariyani & Fitri, 2023).

Digital educational games are created to help children actively gather knowledge, improve understanding, and develop strategies as they play. Digital educational games also offer advantages in terms of presentation, including text, sound, video, graphics, animation, and interaction (Casañ, 2018). Educational games are very interesting to develop when compared to traditional teaching techniques, educational games provide benefits. Educational games that mimic problems are created to capture the essence of the information needed to solve challenges. One of the learning media with this learning pattern is educational games (Humaida & Suyadi, 2021).

Logical-Mathematical Intelligence

Gardner (Wang et al., 2019) argues that children who are gifted in mathematics and logic usually like counting games, classifying objects, asking questions, exploring, making cause-and-effect relationships, and various other activities. According to him, every human being can use numbers and reasoning (Wang et al., 2019). Armstrong defines that one of the characteristics of a person with high logical-mathematical intelligence is that he excels in managing numbers accurately and effectively (Suripatty et al., 2020).

According to Mukarromah (Nisa et al., 2020), mathematical logical intelligence incorporates high levels of computation and systematic thinking. Because it places a high value on logic and counting, mathematical logical intelligence is strongly associated with maths. Individuals with a high mathematical logical IQ can understand and solve any mathematical puzzle with ease (Maemanah & Winarso, 2019).

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A person who loves numbers and can reason well through most challenges in daily life is said to have a logical-mathematical intelligence that is more dominant than other intelligence. The first step in developing logical intelligence is to understand basic mathematical ideas such as Long-short, high-low, big-small, and many-little, as well as problem-solving, logical and scientific reasoning, number recognition, and the number of items corresponding to each number (Rahmalia & Suryana, 2021).

According to Hartini (Nabighoh et al., 2022). , logical-mathematical intelligence has the following objectives: 1) Learning to classify items based on certain criteria; 2) Improve counting skills by mentioning numbers from 1 to 10; 3) Acquire expertise in estimating levels such as long-short, big-small, and many-little; 4) Encourage pattern recognition skills; 5) Encourage strategic awareness; 6) Encourage the introduction of geometric shapes.

2. METHODS

The findings used a type of research and development (RnD) using the ADDIE Model. RnD research is a type of research carried out to create or produce a product before evaluating its use (Adrillian et al., 2023). The ADDIE model was chosen because it has 5 interrelated stages. Where these five components are arranged systematically, which means that from the beginning to the end, the implementation is carried out sequentially and not randomly. **Figure 1** the following are the stages of ADDIE development:

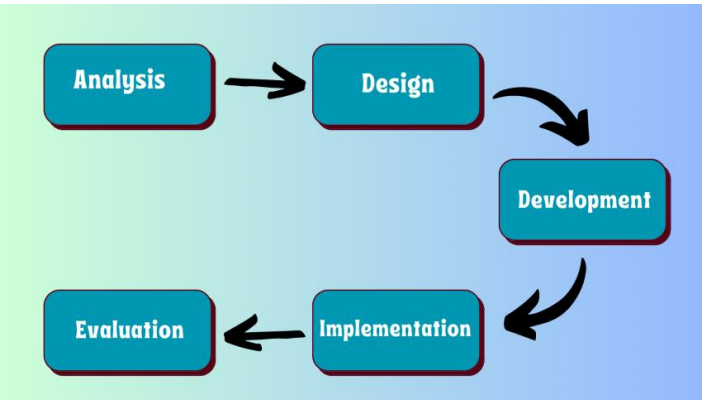

Figure 1. ADDIE Development Stages

In **Figure 1**, that there are 5 stages in the ADDIE model, in the first part, namely *Analysis* which includes starting from curriculum analysis, material, and needs to find problems and solutions that can be provided. Second, namely *Design*, based on the findings of the investigation, researchers began to create logma educational game learning materials at this stage. Product planning that researchers do includes the selection of material to be used, indicators to be utilized, and the concept of the game to be played. Here researchers prepare image assets which will later be designed into an educational game by researchers. Next is *Development*, in this section researchers prepare and make media by compiling the material that has been determined and which will be used in learning activities, then validated starting from design expert validation, and academic material expert validation. Furthermore, the *Implementation* stage, this stage is carried out to test the feasibility of the media that has been produced. The participants of this study were group B children and one teacher from the PAUD institution to test the practicality of the logma educational game. The last stage is *Evaluation*, which is the final assessment after carrying out all stages. In this final part, the researcher makes adjustments or revisions by considering the expert team's assessment,

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teacher evaluation, student feedback, and other factors to ensure that the finished product is suitable for use in improving children's logical-mathematical intelligence.

Sources of information were obtained through questionnaires, interviews, observation, and documentation. Data collection uses the level of validity and practicality. **Table 1** to see the validity and practicality of the media, researchers used a Likert scale with the following intervals:

Table 1. Validity and Practicality Scale

Intervals (%)	Validity Category	Practical Category
0 % -21 %	Very Invalid	Not Very Practical
21 % - 40 %	Not Valid	Not Practical
41 % - 60 %	Moderately Valid	Moderately Practical
61 % - 80 %	Valid	Practical
81 % - 100 %	Very Valid	Very Practical

In **Table 1.** The determining interval is said to be valid and practical, according to Sudjono (Maulidta & Sukartiningsih, 2018) if the percentage of feasibility is between 61% and 80% of all points on the validation assessment questionnaire given by material experts, media experts, and educator response questionnaires.

3. RESULT AND DISCUSSION

The stages of Analysis, Design, Development, Implementation, and Evaluation are the five stages that make up the ADDIE paradigm. The five stages are as follows :

Analysis Stage

The analysis stage has 3 stages, where at each of these stages the researcher sets the background for the development of this educational game, among others:

Needs Analysis, A performance analysis was conducted to ascertain what educational materials the children needed. Based on the results of the performance analysis, solutions to the problems in the field were found. This involved creating fun educational tools for children using existing technology and learning media and then proceeded to create a development plan that suited the needs of the field. To improve the logical-mathematical intelligence of early childhood, researchers created a digital-based logma educational game. The obstacles obtained from the teaching and learning process are 1) In number recognition activities, children often have difficulty in distinguishing the numbers written; 2) Children only know the pronunciation of numbers but still have difficulty recognizing the symbol of the number symbol; 3) Children also still have difficulty in mentioning events that occur due to cause and effect in everyday life; 4) Difficulty in solving problems in-game activity and; 5) There are technology facilities that are not optimally used in delivering learning materials.

After knowing that a medium was needed to assist learning, the researcher conducted a Curriculum Analysis, Curriculum Analysis is carried out to see the curriculum applied at school, understand the core competencies and basic competencies, and see what aspects are in counting activities, classify objects, asking questions, exploring, and activities regarding cause-and-effect relationships that can be used as a reference for developing Logma Educational Game learning media. So that in the media design planning stage, the structure and components of the media are by the syllabus used.

After knowing the curriculum used, then the material analysis, where the researcher analyses the material that students will learn in the logma educational game. The material to be learned in this game is mathematics and problem-solving.

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Design Stage

The second stage in the ADDIE model is design. Based on the findings from the investigation, researchers are now starting to make logma educational game learning media. The product planning that researchers do includes the selection of materials to be used, indicators to be utilized, and the concept of the game to be played. Here the researcher prepares image assets from Google which will later be designed into an educational game by the researcher.

In addition, product development is the first stage where researchers create items based on the results of planning. The product for the logma educational game includes the front page (start the game), the menu page includes 3 game levels at each level including matching pictures, recognizing numbers 1-10, recognizing number symbols, recognizing the concept of orders, cause-and-effect, classifying objects based on color shape size, and counting.

Development Stage

At this stage, researchers prepare and make media by compiling the material it that has been determined and will be carried out in learning activities, then carry out validation starting from media expert validation, and material expert validation. At the material validation stage, the validator provided input related to measurable synthesis and observation items that were adjusted to the activity indicators. The validator also said that the game activities developed do not need one indicator for one menu of game activities, but just one game level covering all indicators. In addition, the material presented in the game must be adjusted to the indicators in logical-mathematical intelligence. **Figure 2** from the validation results, the following results were obtained :

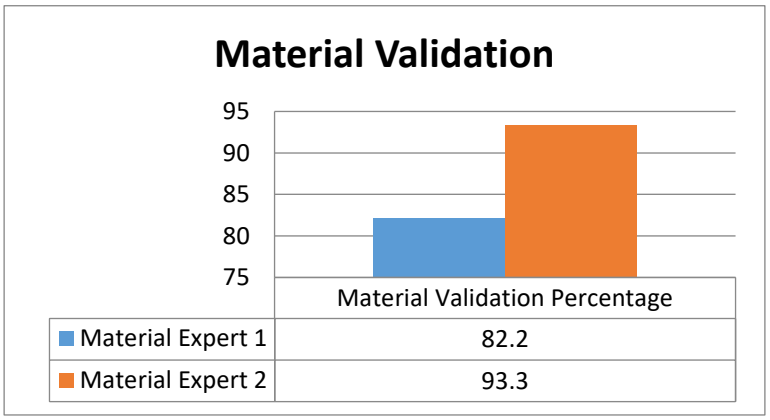

Figure 2. Material Expert Validation Results

Sourced from the **Figure 2.** The results of the material expert questionnaire assessment on digital-based logma educational games to increase logical-mathematical intelligence have a material expert I validity level of 82.2% and material expert II validity of 93.3% that the product in the form of digital-based logma educational games developed by researchers is very feasible to use to increase children's logical-mathematical intelligence.

Furthermore, researchers conducted media validation to see the design of the media that would be used later. At this stage, there were several changes suggested by the media expert validator. **Figure 3** the following are some of the changes made by researchers to develop digital-based Logma Educational Games on children's Logical-Mathematical Intelligence.

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(a) **(b)**

Figure 3. Images of Logma Educational Game before (a) and after (b) design validation

In **Figure 3.**, It can be seen that there are changes in the tree background used, the size of the numbers and the fruit assets. The colors used previously seemed to blend into the tree which made it difficult to distinguish the fruit assets, and the size of the numbers, and fruit images were too small to be visible to children when playing. **Figure 4** the following are some of the changes made by researchers to develop digital-based Logma Educational Games on children's Logical-Mathematical Intelligence.

(a) **(b)**

Figure 4. Images of Logma Educational Game before (a) and after (b) design validation

Figure 4. Explaining that the value object is omitted, to be consistent in each game menu is not given a number value object but is given appreciation in the form of sound effects and supporting assets. **Figure 5** the results of the media validation test obtained the following results:

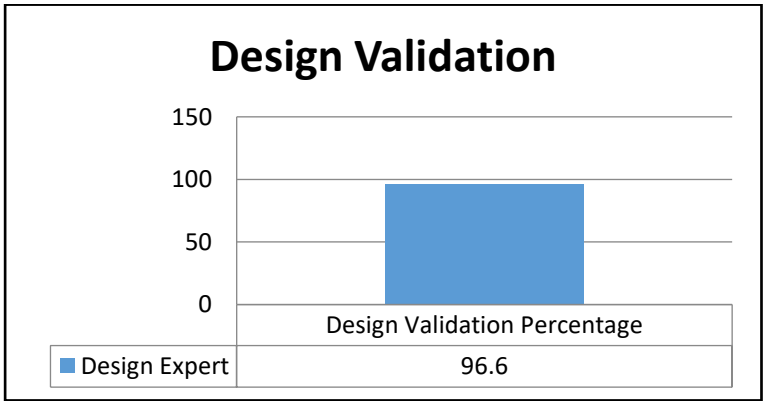

Figure 5. Design Expert Validation Results

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Seen from the **Figure 5.** The results of the media expert questionnaire assessment on digital-based logma educational games to increase logical-mathematical intelligence have a validity level of 96.6% categorized as very valid. Therefore, it can be said that the digital-based logma educational game developed by researchers is very feasible to use and test in the field. Value objects were removed from every game menu to ensure consistency and focus on a deeper user experience. By replacing objects of value with appreciation such as sound effects and supporting assets, users can be more emotionally engaged and more connected to the game. Media validation test results show that users responded positively to this approach. They feel more engaged and entertained by the use of sound effects and supporting assets than by simply acquiring an object of value. This indicates that the game experience becomes more memorable and interesting without having to depend on providing value objects.

Implementation Stage

After validation, the next stage is implementation, in this section the level of practicality of the product developed is carried out. The practicality test stage is carried out with two stages, namely one-to-one and small grub testing the logma educational game product using interview questionnaires and observations by researchers. Data on the practicality of logma educational games by children can be seen from the child's ability to play logma educational games and the child's understanding of the material in the game. **Figure 6** the results of the distribution of questionnaires to see the practicality of the Logma Educational Game by Educators are as follows:

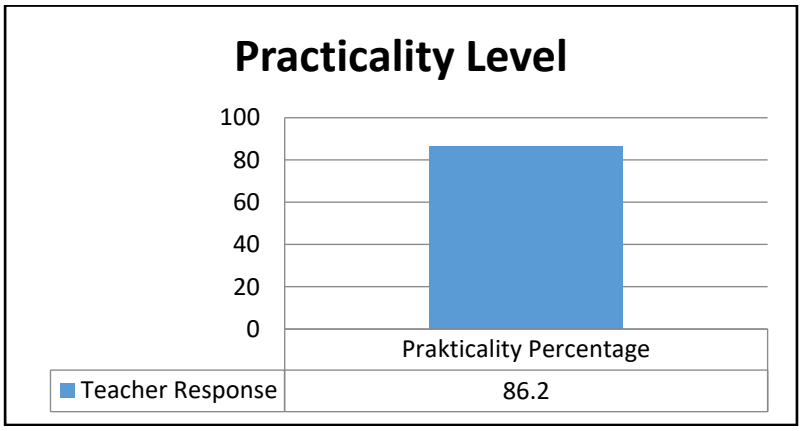

Figure 6. Practitioner Assessment Results

Based on the **Figure 6.** The results of the practitioner's assessment related to the implementation of digital-based logma educational games to increase logical-mathematical intelligence have a practicality level of 86.2% which is in the "very practical" criteria. From the practicality level interval, the score range of 81-100 can be categorized as "very practical". **Table 2** from these results, it can be said that logma educational games are suitable for use.

Table 2. Results of Small Scale Trial (one to one) Practicality Level by students

Name	Total	Practicality Level	Category
FSZ	45	100%	Very Practical
RAD	43	95,5%	Very Practical
GEA	45	100%	Very Practical
MS	44	97,7%	Very Practical
APA	39	86,6%	Very Practical
Total	216	96%	Very Practical

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Based on the **Table 2.** From the assessment of the results of the small-scale trial on 5 students, it has reached the "very practical" category. From this data, the researcher sees that the logma educational game is by the indicators that were assessed during observation such as 1) solving problems; 2) understanding the concept of cause and effect; 3) understanding the concept of commands; 4) knowing numbers and number symbols; 5) recognize colors, shapes, and sizes; 6) easy to use and; 7) more fun. With a practicality level of 86.2%, the application of digital-based logic educational games to improve logical-mathematical intelligence is considered "very practical" according to practitioners' assessments. The score range of 81-100 is indeed categorized as "very practical", which shows that this approach is effective and easy to apply in a learning context. This indicates that the game can provide significant benefits in developing logical-mathematical intelligence in users. **Table 3** therefore, with the suggestions and input, improvements will be made at a later stage to continue the large-scale trial.

Table 3. Results of Large-Scale Trial of Practicality Level by Learners

Name	Total	Practicality Level	Category
ANH	41	98,5%	Very Practical
AIS	40	91,4%	Very Practical
ASR	45	100%	Very Practical
AAR	42	94,2%	Very Practical
DAN	41	92,8%	Very Practical
HAH	39	91,4%	Very Practical
MOA	45	98,5%	Very Practical
MAA	39	91,4%	Very Practical
MGAA 1	41	94,2%	Very Practical
MGAA 2	45	100%	Very Practical
MSY	42	94,2%	Very Practical
MTP	39	90%	Very Practical
NMA	45	100%	Very Practical
RAP	42	95,7%	Very Practical
ZDH	42	94,2%	Very Practical
Total	629	93,1%	Very Practical

Based on the **Table 3.** The result of the calculation of the average level of practicality of the large-scale trial results is 93.1%. The interval criteria of 81-100, shows that using logma educational games as a learning resource at school is very practical. The questionnaire filled in by learners can be used to measure how practical they are in testing the product. Through observations and interviews, the questionnaire was completed. For each statement, the researcher will give a tick mark according to how the students responded to it during the study. The results from the small-scale trial resulted in a practicality rate of 96%, while the large-scale trial resulted in a practicality rate of 93.1%, based on the learners' instrument questionnaire. It can be seen that children can learn a lot from the Logma Educational Game, both in class and independently.

Evaluation Stage

At this stage, to assess the level of understanding, a second data review was conducted using recommendations from experts in the field of ECD design and content as well as questionnaires used in student trials during the implementation stage. The results of the above research indicate that the use of digital-based logma educational games is feasible and

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practical to be utilized in improving the Logic-Mathematical Intelligence of early childhood. Learners can solve problems, able to know the concept of cause and effect, able to recognize numbers, recognize colours, shapes, and sizes and implement them in everyday life after playing this game. Logma educational games can be used by children to learn independently and are fun to play to increase children's interest in continuing to learn.

Based on the findings above, it can be concluded that the logma educational game that has been made by researchers is very valid and practical to be used in increasing the logic-mathematics intelligence of early childhood. Gardner's theory is that children who are gifted in mathematics and logic usually like counting games, classifying objects, asking questions, exploring, and making cause-and-effect relationships. Logma educational games can increase children's motivation, interest, and enthusiasm for knowing mathematics and problem-solving. Logma educational games are also able to utilize technology in the learning process.

The use of technology in education will increase the effectiveness of the learning process, the utilization of learning materials must also take advantage of these technological advances so that later the quality of education will be better. One of the learning tools that utilize modern technology is educational games, which present specialized and visually appealing material for children to acquire the content within.

The game developed is a logma educational game which is a development of a student worksheet (LKPD). Logma educational games are designed in digital form. Given that children need digital educational games that are by digital native conditions, the creation of digital educational games must be improved and continued. Children who are digital natives are those who are accustomed to accessing technology in their daily lives, especially in the education process (Çimen & Hangül, 2021).

4. CONCLUSION

The development of the Logma Education Game to increase logical-mathematical intelligence in early childhood can be applied in PAUD units. This can be proven from the results of the material expert validation test and media expert validation which say that the Logma Educational Game is a valid medium in the learning process in the context of logical-mathematical intelligence. Based on the findings, it can be seen that the feasibility of the digital-based Logma Educational Game to increase the Logic-Mathematical Intelligence of Early Childhood is validated by several validators to obtain a valid category, the results of the Logma Educational Game media validation assessment are 96.6%, which is in the very valid category. The results of the validation assessment of academic material I, namely 82.2%, and academic material II, namely 93.3%, both values are in the very valid category.

In addition, from the practicality test, it can also be seen that the Logma Educational Game is very practical in learning at PAUD institutions and independent learning at home. The results of the Logma Educational Game assessment of the level of practicality by the teacher's response were 86.2% and the results of the one-to-one (small scale) trial by students obtained a level of practicality of 96%, for the large-scale trial obtained a level of practicality of 93.1%, the value is in the very practical category.

Therefore, it can be proven that the digital-based Logma Educational Game is very feasible for increasing the logical-mathematical intelligence of early childhood. In the future, researchers hope that the Logma Educational Game can be developed again with different materials and other Intelligence. Given that this research is limited to material and indicators regarding Logic-Mathematical Intelligence, the researchers hope that the Logma Educational Game can be developed again with different material and on other Intelligences.

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5. AUTHORS' NOTE

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