Improving students' mathematical identity using games as learning media during the Covid-19 pandemic

L R Hima1,*, T Nusantara2, E Hidayanto2, S Rahardjo2 and T R Murniasih3

1 Universitas Nusantara PGRI Kediri, Jl. KH. A. Dahlan No. 76, Kediri, Jawa Timur, Indonesia
2 Universitas Negeri Malang, Jl. Semarang No.5 Malang, Jawa Timur, Indonesia
3 Universitas PGRI Kanjuruhan Malang, Jl. S. Supriadi No.48, Malang, Jawa Timur, Indonesia

* E-mail: linarihatul@unpkediri.ac.id

Abstract. During the COVID-19 pandemic, Indonesia has applied digital learning methods for all school levels. It is undeniable that digital learning also brings out boredom for students. This saturation decreases student motivation to learn, coupled with anxiety about the uncertain pandemic situation. Decreased motivation and increased anxiety are related to the mathematical identity possessed by students. As a result of this decline, the mathematical identity of the students is also not good. This research was conducted to improve student mathematical identity by using games as learning media. Data were collected from two fifth-grade elementary school students who have a low-category mathematical identity. This research is qualitative research using a case study approach. The results showed that the games used as learning media succeeded in improving students' mathematical identities. Other findings indicate that the circumstances around students, such as a pandemic, reduce students' mathematical identity. Therefore, it is hoped that teachers' creativity in developing students' mathematical identities is expected because the development of students' mathematical identities strongly depends on the treatment of the environment around them, such as teachers, friends, and even the learning media they use.

1. Introduction

The COVID-19 pandemic has hit most parts of the world with high death rates recorded in various countries, such as the United States, Turkey, Italy, and other parts of Europe and Africa; the death toll continues to rise. In Indonesia, COVID-19 cases have also been confirmed. The Indonesian government announced that all schools should not carry out classroom learning [1]. All schools conduct online learning, and it is not certain when classroom learning will take place. All policies are adjusted to the current situation and conditions taking into account the development of the pandemic. This is done to prevent the spread of coronavirus and protect students, teachers, and lecturers. Given the COVID-19 pandemic, which has resulted in several countries locked down, there is a paradigm shift in the learning process around the world. Most educational institutions are shifting face-to-face classes to digital learning. The majority of students currently enrolled in educational institutions around the world are changing the way they learn from physical classes to digital learning education. In Indonesia, all
education levels have carried out digital learning, from elementary schools, junior high schools, high schools to higher education institutions.

Both in-class learning and digital learning have the potential to generate saturation, which is directly related to student learning motivation. When this saturation appears, students are not interested in learning mathematics. Therefore, there must be a tool that can be used to reduce this saturation. Moreover, during the pandemic, students can no longer go out with their friends or even just take a walk outside their home. This situation has led to the idea of researchers to create interesting games. A game is a form of multimedia entertainment that is made as interesting as possible to bring out inner satisfaction for the players [2]. Games can be used as a learning tool. Educational games are made with a specific purpose as learning media to learn to recognize colors, recognize letters and numbers, introduce concepts, and solve math problems, or learn foreign languages [3]. Game creators have to take into account various things so that the game can educate, increase knowledge, and improve the players' skills. The games that grab the attention of students are online and offline games. Nowadays, the rapid development of science and technology makes games easily accessible via the internet. From several game genres, a survey conducted by Agate Studio in one of the active game studios in Indonesia and were carried out by more than 1200 gamers, shows that more than 46% of them choose RPG (Role Playing Game) as their favorite game genre [2,3]. RPG (Role Playing Game) is a game in which the players play the roles of imaginary characters and collaborate to develop a story together [3]. The advantage of this RPG genre game is that it can display images in an attractive manner. Thus, the game is very suitable for generating motivation, which is expected to improve students' mathematical identities.

The expected increase in motivation will lead to an increase in mathematical identity. Improving mathematical identity is needed in learning carried out by students [4]. Increasing mathematical identity is necessary because the development of students' mathematical identities affects their mathematical abilities [5]. Not only will it affect their mathematical abilities but also their views, motivations, strategies, and opportunities related to mathematics. Also, students who only passively accept mathematics lessons and describe their relationship with no enthusiasm are less likely to be interested in mathematics, let alone be further involved and just look for ways to get through their learning [4,5]. Those who act like that are rarely active in learning and contribute ideas to improve their mathematical understanding. As a result, the mathematical identity shown will be inconsistent and will not develop for the better during their learning mathematics.

Mathematical identities are explored through a narrative or a collection of stories constructed by a person [6]. This narrative will explain one's involvement with mathematics. Through the narrative conveyed by someone about mathematics, others know the extent of one's attachment to mathematics. The narrative or story conveyed by the student or teacher will show the mathematical identity that has been or is being developed while studying or doing learning activities in mathematics class.

The concept of mathematical identity is part of the general concept of identity. This more specific concept has generated much interest from mathematicians to conduct research related to how to explore and develop mathematical identities. Mathematical identity research subjects are generally students. [4,7]. Therefore research on mathematical identity has become a research trend over the last ten years [8,9]. This is done because identity research is able to reveal more deeply a person's relationship with mathematics. It is also based on the existence of developments that lead to a better direction when someone is known to be able to develop their mathematical identity.

2. Theoretical Framework

2.1. Mathematical Identity
A person's mathematical identity is manifested when telling or writing stories about a person's relationship with mathematics, learning, and teaching. It can be said that a person's mathematical identity is part of his narrative identity [10,11]. Mathematical identity is a context-bound concept. This context allows a person to have many narrative identities connected to a different context or social relationship;
for a mathematical identity, the context is related to activities that involve a person with mathematics [5,8]. Therefore it is essential to follow the development of a person's mathematical identity with regard to their interactions and experiences in society in which they have previously participated.

There are three categories of students' mathematical identities [4]. The three categories are students who have low, media, and high mathematical identities. Each category has an indicator, as presented in Table 1.

Table 1. Mathematical identity indicator for each category.

| Category | Low Category | Moderate Category | High Category |
|----------|--------------|-------------------|--------------|
| I        | Visualize the problem. | Make his/her own problems related to math problems. | Keep trying to solve math problems anytime and anywhere when he/she gets a math problem that he/she has not been able to solve. |
| N        | Be able to explain the solutions used. | Studying proofs related to mathematical problems until he/she is able to understand them. | Spend time to think of other ways or methods that could be used to better solve math problems. |
| D        | Able to connect new knowledge with existing knowledge (acquired). | Find out why his/her remedies did not work. | Develop math skills not only inside but also outside of school. |

2.2. Student identity
Research shows that many students who have low mathematical identity think mathematics is boring, unreal, and useless for everyday life [12]. Fear and dislike of mathematics occur in many elementary, junior high, and high school students so that even those who are able to master mathematics in school tend not to continue to pursue it to higher education [7,11]. Some researchers show that the identity of students is still weak, unstable, and related to other people involved in their lives, for example, teachers, peers, and family members [13]. Types of social relationships that involve students and their surroundings contribute to shaping their identity [11]. In this case, school, family, and the environment are places that can be used to define their identity more deeply [10]. Several studies on identity focus on the influence of teachers in the formation of students' mathematical identities [6]. There are also researchers who argue that the way of teaching or the way teachers deliver mathematics in the classroom affects the formation of mathematical identities [9,10]. Several other studies on identity have focused on the influence of family members and peers on student identity, especially on the extent of the influence. In addition, past mathematical experiences have also been proven to influence current and future mathematical identities [7,9].

2.3. Games on Learning
The theory of the game was first discovered by a group of mathematicians, John Von Neumann and Oskar Morgenstern, who said that the game consists of a set of rules that build a competitive situation from two to several people or groups by choosing a strategy that is built to maximize one's own victory or minimize the opponent's victory [14]. A game is also said to be a system in which the player is involved in an artificial conflict. Here, the player interacts with the system, and the conflict in the game is engineered or artificial. The game also consists of rules, play, and culture, as well as various strategies to maximize self-wins or to minimize group wins. The rules determine the likelihood of action for each player, the amount of information each player receives as progress in play, and the number of wins or losses in various situations.

There are several positive impacts obtained from playing games, namely a) Playing video games makes children familiar with computer technology; b) Games can provide lessons in following directions and rules; c) Some games provide exercises for problem-solving and logic; d) The game
provides training in using motor and spatial skills; e) Games are a means of intimacy and close interaction between parents and children when playing together; f) The game introduces the technology and its various features; g) Some games are able to provide healing tools for certain patients; h) Games are entertaining and fun [15]. In a pandemic situation like today, using games as media of learning is expected to help teachers make it easier for students to understand the concepts conveyed. Games also make students more interested because the displays are more attractive than the regular lessons that are usually given. The focus of providing games as media is to increase student learning motivation during a pandemic. The decrease in motivation has a significant effect on the “mood” of student learning. When motivation decreases, the quality of learning will also decrease. Therefore, the game is expected to be one of the means that can spur student motivation to generate positive attitudes, which are expected to affect the mathematical identity shown. In addition, games are also expected to increase students' creativity in developing material. Because it is easily accessible, games can be taken anywhere when students want to learn so that students are more productive and active.

The game developed in this study is a game that uses RPG Maker MV. RPG (Role Playing Game) is a game in which the players play the roles of imaginary characters and collaborate to develop a story together [3]. The advantage of this RPG genre game is that it can display images in an attractive manner. Also, RPG is a kind of selected game that contains elements of a complex story as well as role-playing art, which makes users feel like being a character who is portrayed in the game [3,15].

3. Method
This research is qualitative research because the data presented is data in the form of narratives and stories of selected subjects. The subject's story will be adjusted to the questions that lead to the conclusion of what mathematical identity the research subjects have. The use of narratives as a way of presenting data which states that one way to know the identity is the narrative of the identity's owner [16]. The instrument in this study was used to explore students' mathematical identities, which were then developed by the author so that they could adjust to the description of each of the identity building components [17,18]. The author used interviews to dig further the information needed. The stories contained in their stories will be summarized, connected, and concluded in such a way as to form a conclusion, which is called a mathematical identity.

Schools that participated in this study were selected by convenience sampling. Due to the COVID-19 pandemic, all schools in Indonesia do not hold face-to-face learning in class. The selection of research subjects based on the results of the mathematical identity questionnaire. The questionnaire was given to all fifth-grade elementary school students. The results of the questionnaire showed that all students had three categories of mathematical identities. Then, the researcher chose one of the categories of mathematical identity to be enhanced. The mathematical identity category chosen is the low category mathematical identity. Next, the researcher selected one male student and one female student to represent this category. These two students are Mark and Sasha (pseudonyms).

After obtaining research subjects, the researcher began to collect data. Data were collected for three consecutive months, from March to May 2020. During these three months, students were given materials that were packaged in the form of a game. This game contains concepts that students must understand, along with exercise questions that must be completed. Questionnaires and interviews were given every week for three months to see the possibility of a research subject’s identity changes.

4. Results and Discussion
The following shows the data on the results of game development as media for learning mathematics and the mathematical identity of the two research subjects (Mark and Sasha).
4.1. Sasha’s Mathematical Identity

4.1.1. Before using the game. When being asked, “Do you like math?” Sasha replied, “Ummm …..(thinking for a long time),” and in the end, she just smiled. When she was asked in more detail, in the end, she replied, "When I take math lessons, all I have to do is listen to and answer questions from my teacher, that is all." The researcher underlined the saying, "that is all," conveyed by Sasha. The sentence "that is all" contains a lot of meanings for Sasha and the Mathematics she is studying. She is not the type of student who was motivated to take math courses to deepen her mathematics knowledge.

Sasha was known to have a low category mathematical identity (based on the results of the initial questionnaire using the "Mathematical Depth Instrument"). However, Sasha was not the type of student who likes to visualize the problem she needs to solve. Sasha was only trying to solve it by connecting the new knowledge with the old knowledge acquired and then trying to solve it. After that, without even trying to explore her abilities, she would just stop at that stage.

4.1.2. After using the game. First Month. When the materials provided were packaged in the form of a game, Sasha’s response was normal at first; it can be said that Sasha was not that interested. The material given at that time was material about fractions. Even though she was taught in the fourth grade, Sasha did not understand the concept of fractions. This made Sasha unable to solve the more complex fraction problem. Sasha was able to solve fractions if the problem given is limited to fraction operations. When she was given narrative questions that require deeper reasoning and understanding of concepts, Sasha was having a hard time. Sasha herself was unable to solve the problem of fractions by visualizing fractions. This adds to the difficulties experienced by Sasha.

Second Month. However, based on the results of questionnaires and interviews, Sasha’s response increased during the second month. Sasha became interested in understanding mathematical concepts better because she had to win the game. The material given at that time was the concept of measuring the volume of cubes and blocks. The visualization in the game was made in such a way as to use real-life images so that Sasha was able to see and think about how to calculate the volume of the two shapes (blocks and cubes). When she was given a narrative question, Sasha could understand the meaning of the problem and look for possible solutions to the problem.

Third Month. Although it was merely because she was interested in the game at first, Sasha’s positive response brought a "fresh breeze" for the researcher. Sasha, who was originally a student with low mathematical identity, on the third month, could now be categorized as a student who has moderate mathematical identity. Based on the questionnaire results, it is known that currently, Sasha is starting to try to solve problems on her own without help from other people (neither friends, teachers, nor parents). This is different from her previous habits because Sasha was known as "lazy" when she had to find out how to solve a problem, and she tended to prefer to be told how to solve the problem first. Furthermore, it was discovered that the good progress that had emerged was that she began to try to find out why the problem solving she was working on was not successful. She would repeat and re-examine the results of her work. This was drastic progress for Sasha. Depicted on a chart, the change of Sasha’s mathematical identity can be described as follows:
4.2. Mark’s Mathematical Identity

4.2.1. Before using the game. For Mark, mathematics was not a fun, boring, and very uninteresting subject. This makes the motivation to learn it also low. He did not have any specific strategy in order to master the materials taught by his teacher. Before being given the game as learning media, Mark was a student who had a low category mathematical identity. In contrast to Sasha, Mark preferred to visualize problems before solving them. The goal was for him to easily understand problems and find ways to solve them. When learning in class, he often found it difficult, especially today when online learning is being implemented, which of course, has very little direct assistance from the teacher, and no friends can help either. He had conveyed his difficulties in learning to the teacher, but Mark still found it challenging to understand the material provided due to limited time and circumstances.

4.2.2. After using the game. First Month. The first two weeks of March, Mark was not interested when he was given the material using the game. This was explained through interviews with the researcher. He said, "Whether it is using a game or not, it is the same. I still cannot do math". The word "cannot" implies that Mark was starting to give up studying mathematics. The difficulties he had experienced have been recognized since he was in the second grade of elementary school. This started with the multiplication material that was difficult for him to understand. As time went on, Mark became more and more left behind from his classmates due to difficulty understanding.

During the first month, Mark was given fractions material through the game as learning media. Based on previous interviews, the researcher tried to convince Mark to try to see the game first. The researchers tried to attract Mark's attention with an attractive game display. Only then would the researchers begin to gradually introduce the material that is included in the game.

Second Month. In the second week of April, Mark felt there was little interest in studying mathematics. This is because teachers were creatively delivering material through game media. The game has made Mark realize that math can also be learned in a more fun way than just reading modules. It has also made Mark curious, motivated and ultimately affected his desire to find answers, learn, and find solutions to mathematical problems in the game.

At first, Mark started observing the game’s appearance, studied the story, and started trying to run it a little. During the first month of providing the games as learning media, the material given was
fractions. Mark had a hard time understanding it because he had not mastered the concept of fractions from the start. During the second month, the material given was material about measuring the volume of blocks and cubes. Delivery through games and stories that he encountered in everyday life had made Mark enthusiastic and interested.

Then he began to ask many teachers, friends, or relatives about how to win the game. The way to win the game is none other than being able to solve math problems given in the game. The only way to solve math problems is to understand the concept of measuring the volume of cubes and blocks.

*Third Month.* Mark even asked, "*Why are not all lessons packaged in game form? I must really like it*". This statement led the researchers to argue that his interest in games made his outlook change for other subjects. The researchers consider this change in perspective as a positive sign that can change Mark's mathematical identity. Currently, Mark is also included in students who have a middle category mathematical identity. This is because Mark is willing to solve math problems independently, without the help of others. He is also willing to study the evidence related to solving the problem he is working on. Currently, Mark is also interested in learning to make games that can be used in other materials or even other subjects besides mathematics.

Based on the data, it is known that games can change and even improve students' mathematical identities. The researchers suggest to readers that the results of this study can provide new insights that mathematical identity can develop into a strong mathematical identity according to the treatment given to someone (in this case, students). In this study, the treatment given was the provision of games as learning media. It is good for readers to focus not only on games as media but also on the way proper treatment can change and even enhance mathematical identity.

Mark and Sasha are a small sample of the many students who have low category mathematical identity. Games as learning media as the right treatment have succeeded in changing their perspective on mathematics. The appropriate treatment is obtained based on the results of in-depth observations and can only be done by their teacher as someone who monitors their learning progress every day. The game here is successful learning media, but this may not apply to other students with the same mathematical identity category. In-depth observation is needed to determine what kind of treatment is needed by students to improve their mathematical identities.

Identity has the nature of changing over time, different environmental conditions, and other things around students. This trait can be used by teachers in order to be more enthusiastic about improving students' mathematical identities or maintaining good mathematical identities.

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References

[1] Mulenga E M and Marbán J M 2020 Is Covid-19 The Gateway For Digital Learning In Mathematics Education? Contemporary Educational Technology 12, 2, p. 269.
[2] Barreto D Vasconcelos L and Orey M 2017 Motivation And Learning Engagement Through Playing Math Video Games. Malaysian Journal of Learning And Instruction 14, 2, p. 1–21.
[3] Fareka S H 2019 Penggunaan Game Rpg Maker Mv Untuk Menganalisis Kemampuan Berpikir Kreatif Matematik Siswa Pada Materi. p. 499–507.
[4] Hima L R, Nusantara T, Hidayanto E and Rahardjo S 2019 Changing In Mathematical Identity of Elementary School Students Through Group Learning Activities. International Electronic Journal of Elementary Education 11 5
[5] Kaspersen E and Pepin B 2017 Measuring STEM Students’ Mathematical Identities. Educational Studies in Mathematics 95 2 163-179
[6] Sfard A and Prusak A 2005 Identity That Makes A Difference: Substantial Learning As Closing The Gap Between Actual And Designated Identities
[7] Anderson R 2007 Being A Mathematics Learner: Four Faces of Identity The Mathematics Educators 17 1 7–14
[8] Esmonde I, Brodie K, Dookie L and Takeuchi M 2009 Social Identities And Opportunities To Learn: Student Perspectives On Group Work In An Urban Mathematics Classroom Journal of Urban Mathematics Education 2 2 18–45
[9] Radovic D, Black L, Salas C E and Julian Williams 2017 Being A Girl Mathematician: Diversity of Positive Mathematical Identities In A Secondary Classroom. Journal For Research In Mathematics Education 48 4 434
[10] Martin D B 2012 Learning Mathematics While Black (Winterspring: Educational Foundations)
[11] Grootenboer P, Smith T and Lowrie T 2006 Researching Identity In Mathematics Education: The Lay of The Land Identities, Cultures and Learning 12–615
[12] Ingram N 2011 Affect And Identity: The Mathematical Journeys of Adolescent
[13] Kaasila R, Laine A and Pehkonen E 2005 Autobiographical Narratives, Identity And View of Mathematics Cerme 4 215–224
[14] Beijaard D 2006 Teachers’ prior experiences and actual perceptions of professional identity Teachers and Teaching 12 281-294
[15] Chu M W and Fowler T A 2020 Gamification of Formative Feedback In Language Arts And Mathematics Classrooms: Application of The Learning Error And Formative Feedback (Leaf) Model. International Journal of Game-Based Learning 10 1 1–18
[16] Gellert L M 2013 Elementary School Teachers and Mathematics: Communities of Practice And An Opportunity For Change Journal of Education And Learning 2 4 113–122
[17] Owens T J, Robinson D and Smith L 2010 Three Faces of Identity
[18] Rosemary M D 2017 Forming positive identities to enhance mathematics learning among adolescents Universal Journal of Educational Research 5 2 175–180