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GAME-BASED LEARNING MEDIA ON SYSTEM OF UNITS MATERIAL BASED ON ASSESSMENT ANALYSIS RESULTS FOR CHILDREN WITH MATHEMATICS LEARNING DIFFICULTIES

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Abstract

This research aims to develop educational games and learning media using Android-based technology on International System of Units (SI) material for children with mathematics learning barriers on the material. The research method used in this research is the design-based study (DBR) to obtain comprehensive information in analysing learning difficulties experienced by students and the basis for developing game-based learning media. The subjects in this study were students with mathematics learning disabilities in SI material. The result of this study is the development of educational games and learning media using Android-based technology on SI material for children with mathematics learning difficulties. The content contained in educational games and learning media has been adapted to the needs of children who have learning disabilities in SI material. The material in game-based learning is tailored to the learning needs of students, namely in SI. The results showed that educational game media using Android-based technology can improve learning needs for SI material. In addition to being useful for children with special needs, this educational game learning media is also expected to be used for other children who are learning mathematics using SI material.

Keywords: Assessment, Game, Mathematics difficulties, Media, Technology.

1. Introduction

Mathematics is a basic skill that individuals need to have because it will contribute to other disciplines such as science, economics, accounting, science, and technology [1-4]. Mathematics is one of the fields of study that need to be learned because by studying mathematics, an understanding of the patterns of change will be formed. The purpose of learning mathematics is to encourage children to think logically, critically, and rationally. That is why many reports relate to teaching and learning in mathematics (see Table 1).

Table 1. Previous studies on teaching and learning in mathematics.

No.	Title	Ref.
1	Association of interest, attitude and learning habit in mathematics learning towards enhancing students' achievement.	[5]
2	Prototype of greenhouse effect for improving problem-solving skills in science, technology, engineering, and mathematics (STEM)-education for sustainable development (ESD): Literature review, bibliometric, and experiment.	[6]
3	Augmented reality for cultivating computational thinking skills in mathematics completed with literature review, bibliometrics, and experiments for students.	[7]
4	Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model.	[8]
5	Difficulties encountered by the students in learning mathematics.	[9]
6	Global research trends of mathematics literacy in elementary school: A bibliometric analysis.	[10]
7	Effect of guided inquiry and explicit-instructional strategies on lower basic students' academic performance in mathematics. Indonesian	[11]
8	Self-efficacy as a correlate of pupils' academic achievement in mathematics.	[12]
9	Computational thinking in mathematics learning: Systematic literature review.	[13]
10	Improvement of students' literacies skills in the knowledge aspect through science, technology, engineering, and mathematics (STEM)-integrated module.	[14]
11	Students' attitude towards gamification-based teaching in mathematics in basic schools.	[15]
12	Effect of round robin instructional strategy on pupils' academic achievement in mathematics.	[16]
13	Examining sources of mathematics self- efficacy beliefs of senior secondary school students.	[17]

Table 1. (Continue). Previous studies on teaching and learning in mathematics.

No.	Title	Ref.
14	Personal and contextual factors as correlates of entrepreneurial intentions among pre-service science, technology, and mathematics teachers.	[18]
15	Effect of reversed jigsaw instructional strategy on pupils' academic achievement in mathematics.	[19]
16	Primary teachers' mathematics anxiety and mathematics teaching anxiety as predictors of students' performance in mathematics.	[20]
17	Altering students' mindsets and enhancing engagement in mathematics in a problem-based learning.	[21]
18	Developing the ability to add integer through live worksheets among grade II pupils with autism in mathematics learning.	[22]
19	Efforts to increase the interest of junior high school students in mathematics lessons using the tik tok learning tool.	[23]
20	Math readiness and its effect on the online academic performance of science, technology, engineering, and mathematics students.	[24]
21	Assessing teachers' formative evaluation strategy as related to senior secondary school students' achievement in mathematics.	[25]
22	Exploration of the effect of scaffolding instructional strategy on pupils' academic performance in mathematics.	[26]
23	Effect of peer-tutoring strategy on senior secondary school students' achievement in mathematics.	[27]
24	Exploring effective differentiated instruction in the teaching and learning of mathematics.	[28]
25	Impact of single parenting on academic performance of junior secondary school students in mathematics.	[29]

Mathematics can improve the ability to think and solve problems [30]. Mathematics educators generally agree that learning and teaching mathematics requires different skills from learning other subjects. As a result, the games created and used to teach mathematics are not always the same as the games used to teach other subjects [1]. The use of game-based learning media is one of the learning approaches for students in the 21st century [31]. Several studies have developed learning media. As a preliminary study, we analysed several studies. Table 2 explains the analysis of preliminary study results obtained from previous researchers.

Table 2. Preliminary studies relating to games in supporting teaching and learning.

No.	Title	Ref.
1	Digital game-based learning in a Shanghai primary-school mathematics class: A case study	[32]
2	Kahoot-based learning game to improve mathematics learning motivation of elementary school students	[33]
3	The role of learning styles in game-based learning. International Journal of Game-Based Learning (IJGBL)	[34]
4	Towards successful game-based learning: Detection and feedback to misconceptions is the key	[35]
5	Defining digital game-based learning for science, technology, engineering, and mathematics: a new perspective on design and developmental research.	[31]
6	The use of the Natuna game about the natural wealth of the natuna marine on national awareness of the post-millennial generation.	[36]
7	Examining the effects of online games on the academic performance of BPEd students of Sultan Kudarat State University, Philippines.	[37]
8	Ways to develop education for obtaining general physical qualities of young wrestlers through action games.	[38]
9	Post-traumatic counselling through group games.	[39]
10	Effect small side games (SSG) on playing skills in handball sports.	[40]
11	Rehabilitation program for surgical shoulder joint protrusion among team games players injured.	[41]
12	Basic arithmetic learning through mathematics online games for elementary school students during the pandemic.	[42]
13	Android application for smart diagnosis of children with disabilities and its correlation to neuroscience: Definition, literature review with bibliometric analysis, and experiments.	[43]

Overall, the literature on game-based learning in mathematics highlights the potential benefits of incorporating digital games into the educational environment to improve student engagement, motivation, and learning outcomes. By using android-based technology on SI material, this research aims to develop and test effective game-learning media for children who face difficulties in learning mathematics. Android-based technology is effective to support teaching and learning [44, 45]. The novelties in this research are (i) the development of game-based learning media on SI material consisting of units of weight, length, and time, and (ii) the development of game-based learning media on SI material based on the results of the analysis of learning difficulties experienced by students.

To obtain comprehensive information, this study used a descriptive qualitative approach. A child who has difficulty learning SI material is the subject of this study. This study found that game-based learning media can be created for children with learning difficulties using SI materials. The content in the game learning media has been adjusted to the needs of children who face learning difficulties in SI material. Materials that are tailored to the needs will be ideal for the learning development of children who face learning difficulties in SI material. The results of this study indicate that educational games that use Android-based technology can increase students' need to learn SI material. This game-learning media can also be useful for children who face learning obstacles in SI material.

2. Literature Review

2.1. Game based learning

Game-based learning is a learning method that integrates educational content into video games to assist learners in learning [46]. Figure 1 explains the components of game-based learning. Game-based learning consists of technology-based media, learning, and games. These three components are the needs of today's learning. Thus, it is important to realize them. Game-based learning tries to utilize the entertainment value of digital games for educational purposes [47]. With the entertainment value inserted in learning, it is expected to make students more interested in learning. Thus, the results obtained are more optimal. Game-based learning can be used on several devices, such as computer games, educational games, video games, cellular phones, and online applications [48, 49].

Game-based learning is a learning media that uses a game plot to learn a certain material. Digital game-based learning can have a positive impact on students' academic knowledge [50]. Digital game-based learning media can facilitate students to learn anywhere and anytime [51]. Students have a positive attitude towards game-based learning on mobile devices [31]. Media is essentially one of the components of the learning system. As a component, the media should be an integral part and must be following the learning process. Thus, the development of learning media is very beneficial for teachers, teachers can be effective and efficient in presenting subject matter if they can utilize the media properly and appropriately [52].

Game-based learning development is one of the efforts to keep up with science and technology in the learning process, in its development game-based learning needs to be adjusted to the characteristics of students. Thus, it is appropriate. Game-based learning can be accessed through devices. The use of Android-based devices is becoming increasingly massive along with the times, various kinds of technologies such as video games, the Internet, social media, and cell phone applications are developing rapidly in this century [53]. In recent years, android smartphones have maintained the top position in world market share [54]. This android technology can be utilized in learning activities, especially in making learning media [55]. Android application-based innovation is one form of technology utilization to assist learning activities [56].

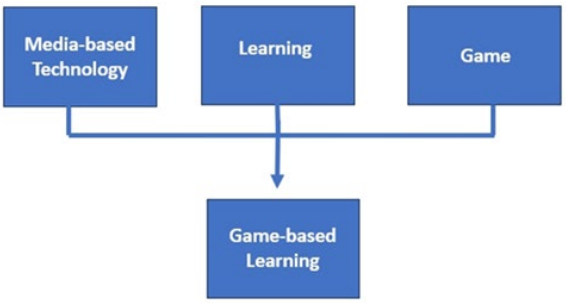


Fig. 1. Components of game-based learning.

2.2. Development of technology-based learning media

Learning Media is a tool used to demonstrate certain facts, concepts, principles, or procedures to make them appear more real/concrete. These tools are intended to provide a more concrete experience, motivate, and increase the absorption and memory of students in learning. Media can foster a positive attitude of students towards the material and the learning process. The learning process becomes more interesting when using the right media. Thus, students are motivated to love the science they are learning. A teacher can be effective and efficient in presenting subject matter if he can utilize the media properly and appropriately [52].

The digital world, particularly the Internet of Things, will have an impact on how education is carried out in schools. This development can provide greater benefits for both parties, teachers, and students [57]. The use of digital technology is very effective for students to solve problems because digital media facilitates students to be active in the learning process and stimulates students for discussion compared to if students only respond to commands on the screen or only learn formulas and process procedures [58, 59].

Technological developments provide challenges in the learning process including the interaction between teachers and students, the way students collaborate with other students, the link between technology and mathematics that must be developed, and the digital capabilities of teachers [60, 61]. Mathematics is a subject that is often considered difficult by students, and the use of technology-based media will be very useful for delivering material to students. Students will be more interested in learning because of interactive applications that present sound and images [62].

Teachers' use of games in the classroom environment influences children's perspectives on school and mathematics [63]. One of the goals of teaching mathematics through games is to increase students' love for mathematics and enable them to develop a positive attitude toward mathematics [64]. Game-based learning has a high potential to create a constructive and interactive learning environment [65]. Games provide an environment for children to communicate. From a social point of view, children need to talk, get feedback on their questions, and communicate with peers and teachers to learn mathematics.

The development of game-based learning media must pay attention to several things, including (i) understanding the characters and abilities of students as learners. Thus, the game-based learning design can be effective [66]; (ii) the suitability of game-based learning designed with the material to be taught to help students better understand the material and improve learning outcomes [67]; (iii) stimulation to improve motivation and learning culture [68]; (iv) easy usage for students [69].

In the mathematics learning process, the use of learning media can help understand concepts. Thus, it is important to develop learning media [70]. The use of monotonous learning methods, such as lectures and assignments, and the lack of media that support learning at school, are other factors that cause students to face learning difficulties [71].

2.3. Mathematics and arithmetics

Mathematics is knowledge and skills that need to be mastered by every human being. Mathematics has become a very useful tool in many things in the intellectual field, such as calculating and measuring objects that are reliable and based on logic [72]. Mathematics is a universal science that drives contemporary technological progress, plays an important role in various disciplines, and improves human thinking [73]. Mathematics is important for students to learn because it is useful for solving everyday problems [74-76]. Therefore, mathematics is often found in the school environment and problems in everyday life [77-79].

Mathematical knowledge and abilities can be accessed through the educational process. Education is a conscious effort to create a learning process that can develop students' potential and build them into strong-willed and moral people carried out by a group of individuals [80-82]. Mathematics in its learning will be analysed complex problems, question, and solve mathematical problems [83]. Mathematics learning has the potential to improve students' ability to think logically, analytically, systematically, critically, and creatively. This ability is needed. Thus, students can obtain, manage, and utilize information to live in an ever-changing, uncertain, and competitive environment.

Figure 2 explains mathematics and mathematics learning material seen from the content of mathematics material consisting of 3 aspects including arithmetic, geometry, and measurement. Arithmetic/algebra, which includes numbers and computation, geometry that includes flat and spatial planes, and measurements include length, circumference, area, content, weight, and time [84]. The process of learning mathematics can be taught in two aspects, including quantitative aspects, which include understanding and ability of concepts and techniques. Qualitative dimension, which includes finding solutions to problems.

Mathematics is very useful for solving problems in everyday life. Mathematics is widely used in everyday life to solve various problems, such as playing games, managing finances, building a house, etc. This shows how important mathematics is to success and solving problems correctly. Solving mathematical problems involves stages such as understanding the problem, planning a solution, implementing the plan, and re-evaluating.

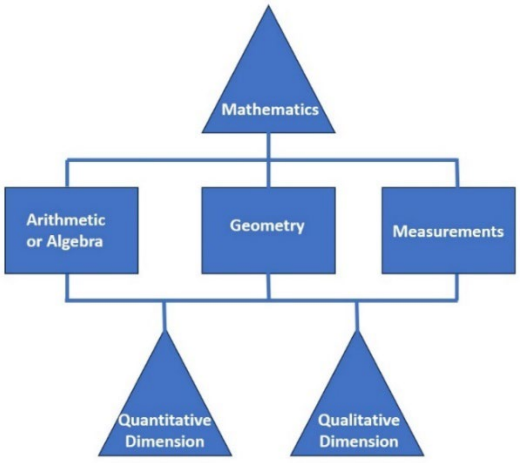


Fig. 2. Aspects of mathematics learning.

2.4. Components of the international system of units

Mathematics has several components including arithmetic/algebra, geometry, and measurement [84]. Measurement is one of the mathematical sciences that has an international system with the aim that the measurement system can be used internationally [85, 86]. Internationally, measurement is The International System of Units (SI). Table 3 explains the 7 components of SI, namely length, weight, time, electric current, thermodynamic temperature, amount of substance, and light intensity.

Table 3. Components of SI.

No.	Unit icon	Name	Description	Icon symbol
1	Long	L, x, r	Meter	m
2	Weight	M	Kilogram	kg
3	Time	T	Second	s
4	Electric current	I, i	Ampere	A
5	Thermodynamic temperature	T	kelvin	K
6	Amount of substance	N	Mole	Mol
7	Light intensity	Lv	Candela	Cd

The content of SI starts to be taught in elementary school students from grade 1 to grade 3 with a limited scope. Figure 3 explains the scope of SI taught in elementary school grades 1 to 3 consists of 3 components, namely units of weight, units of length, and units of time [87].

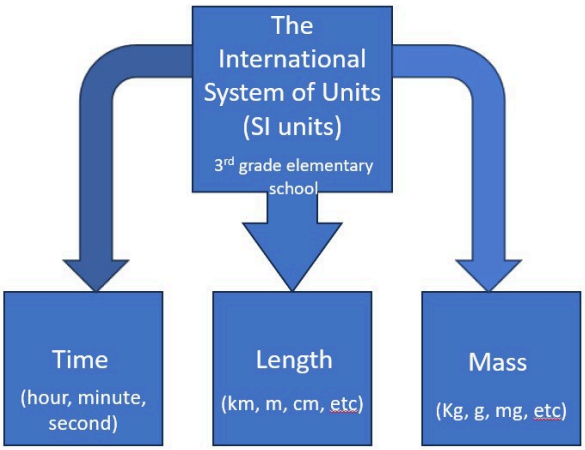


Fig. 3. Grade 1 to grade 3 SI materials in elementary school learning.

Weight is a familiar term for the mass of an object, and every object must have mass. Figure 4 explains the order of weight units including Kilogram (kg), hectogram (hg), decagram (dag), gram (g), decigram (dg), centigram (cg), and milligram (mg). Units of weight are related and can be converted to each other, either by higher or lower ones. Like 1000 g = 1 kg, 1 g = 1000 mg and so on. Scales are a standard measuring tool for calculating the weight of an object. Two types of scales that are very familiar today are digital scales and analog scales [88].

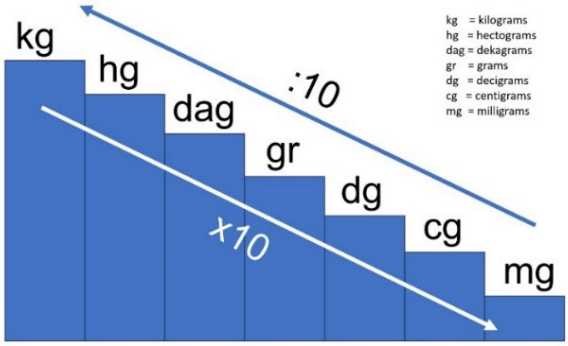


Fig. 4. Unit weight sequence.

The unit of length is an abstract mathematical concept. But even though it is abstract, the concept of length must be understood early as the basis for measuring other units of measurement such as area, volume, and weight. The concepts that must be taught in the unit of length material are the concept of measurement, measuring instruments, measuring units, and changing measuring units. Teaching the concept of length units requires some special approaches, such as the use of methods and media that are concrete and complete. Thus, students can use their audio, visual, and kinesthetics abilities optimally [89]. Figure 5 explains that length units have an order from longest to shortest starting from kilometers (km), hectometers (hm), decameters (dam), and so on.

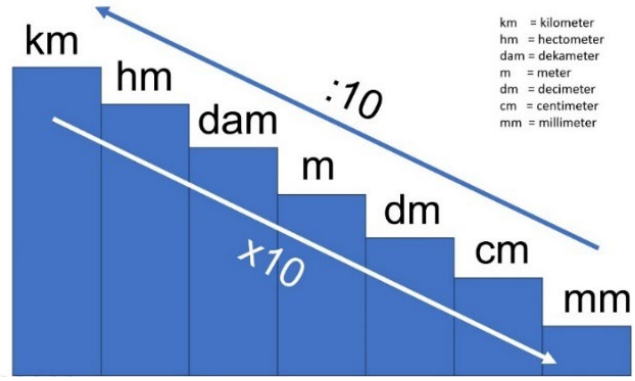


Fig. 5. Unit length sequence.

Humans will always be tied to the concept of Time. Figure 6 explains how time units in analog clocks are often used by individuals. Therefore, the concept of time unit has been included in mathematics learning since elementary school. However, elementary school students often experience problems in understanding the concept of units of time. Thus, a special approach is needed to help students understand the concept of units of time. Students are expected to be able to solve problems related to the unit of time concept after mastering the material about the unit of time concept [90].

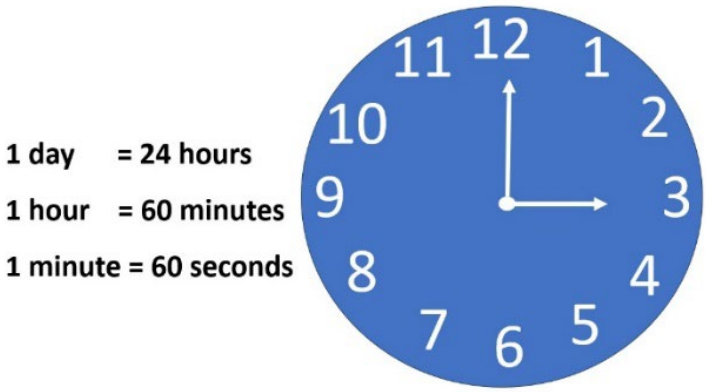


Fig. 6. Time units in analog clocks.

2.5. Development of technology-based learning media

Students tend to just follow lessons without understanding the concepts and theories taught by the teacher, which results in poor learning outcomes [91]. Mathematics is one of the fields that has abstract objects. Thus, to understand it, students need to have good critical and focused abilities [92]. The abstract characteristics of mathematics cause the average student to experience difficulties in learning mathematics [82, 93]. Mathematical concepts are taught gradually starting from the simple and concrete to the complex and abstract. Mathematical concepts need to be taught from definitions to experiences or problems in everyday life [94-96].

Students often have difficulty understanding SI material on length, weight, and time, this is related to the way the teacher informs the learning material [97]. Counting is a complex cognitive process. Figure 7 explains the various kinds of errors students make in mathematical calculations, some of which are (i) mathematics fact errors include errors in the use of drawings, documentation, and use of terms, (ii) mathematical principal errors include mischaracterization of concepts, recognizing cases that are not examples of concepts, providing outlines that do not coordinate concept definitions, and errors in showing connections between conflicting concepts, (iii) mathematical conceptual errors include misuse of concepts and properties. In addition, the inability to connect reality and ideas, as well as errors in connecting two concepts are also included in mathematical conceptual errors, (iv) errors in mathematical skills include errors in determining the results of calculations, errors in the use of properties or definitions, solution strategies, and data in calculations that do not coordinate known information [98].

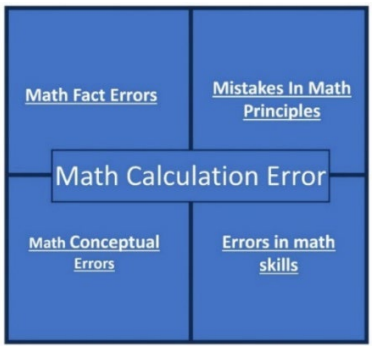


Fig. 7. Time units in analog clocks.

3. Method

3.1. Research subject and research location

This research was conducted at one of the primary schools that organizes inclusive education in Bandung City, Indonesia. The subjects in this study were grade 3 elementary school students. The subject in this study experienced obstacles in learning mathematics on SI material. The SI material taught to the subject is limited to the material of units of length, weight, and time. The subject is important to master this material because it is related to daily life.

3.2. Research design and research procedure

This research uses design-based learning (DBR) to design and develop this game-based learning media. Figure 8 is the procedure in this research. The procedures in this study include identification and analysis, designing game-based learning media, developing learning media, and reflection to obtain game-based learning media.

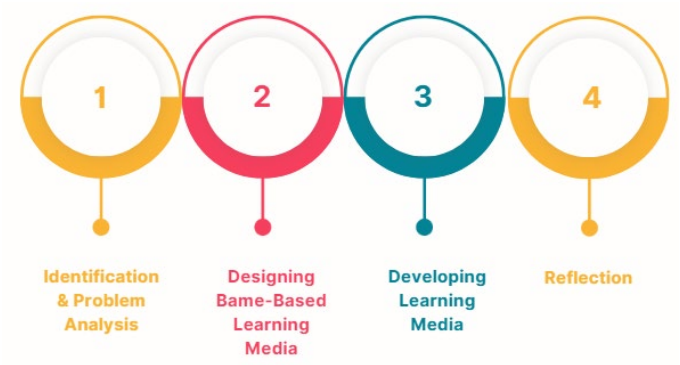


Fig. 8. Research flow.

The first stage contains problem identification and analysis based on the objective conditions of students obtained based on the results of assessments that contain profiles of students' abilities, obstacles, and needs. Analysis of the results of interviews and observations of children, parents, and teachers as a complement. Thus, the data obtained is comprehensive.

The first stage is completed by analysing solutions to overcome children's learning barriers and analysing student potential. The second stage contains the design of learning media as a solution to children's learning barriers and the potential of children. This learning media design is based on the results of analysing problems and opportunities to overcome student learning barriers. The third stage is the learning media development stage based on the design in the second stage. This stage develops the learning media design into a game-based learning media application to overcome learning barriers in students as the goal of this research. The fourth stage is a reflection stage to perfect the game-based learning media that has been designed through limited trials.

4. Results and Discussion

4.1. Identification and problem analysis

Difficulties in learning mathematics can be experienced by every student if not intervened early. The subject has an interest in games on gadgets. Thus, the subject is less interested in the learning process with the lecture method carried out by the teacher, which influences the subject's low academic achievement, especially in the aspect of mathematics. This statement is supported by other research which states that learning problems can be caused by several external factors, such as a non-conducive learning environment, and limited learning facilities at home or school. Thus, children experience learning obstacles that affect academic achievement [99].

Learning difficulties can be divided into two types, caused by internal factors (including IQ, student attitudes towards learning, learning motivation, body health, and sensory abilities) and external children (including teacher variations in teaching, use of learning media, school infrastructure, and family environment). [100].

The subject generally has intellectual abilities in the average range, but the uninteresting learning process causes the subject to be uninterested in the learning process. Table 4 describes the results of the subject assessment analysis which includes the subject's abilities, obstacles, and learning needs in the aspects of mathematics and standard unit material. Individuals who experience learning difficulties do not necessarily have deficiencies or disorders in intellectual or intelligence but are also caused by the design results of ineffective learning [50]. Learning difficulties require alternative problem-solving as a preventive effort. Thus, student development becomes optimal and student learning needs can be overcome.

Table 4. Analysis of assessment results.

No.	Ability	Barriers	Needs
1	Subjects are familiar with weight measurement tools	The subject has not mastered the concept of weight units	Subjects need an understanding of the concept of standard units, the concept of standard unit conversion, and exercises with interesting forms of learning media
2	The subject is familiar with length-measuring instruments	The subject has not mastered the concept of length units	Subjects need an understanding of the concept of standard units, the concept of standard unit conversion, and exercises with interesting forms of learning media
3	Subjects are familiar with time measurement tools	The subject has not mastered the concept of weight units	Subjects need an understanding of the concept of standard units, the concept of standard unit conversion, and exercises with interesting forms of learning media

4.2. Learning media design

The android-based learning media developed on the material in the game is standard unit material. Games-based learning can be downloaded on smartphones to make it easier for students to access educational games anywhere and anytime [51]. Game-based learning is structured with 3 levels of difficulty with easy, medium, and difficult classifications. Table 5 students will face practice questions/evaluation of standard unit material to advance to the next level.

The selection of Android-based technology is based on students' interest in games and gadgets. Besides that, when technology develops rapidly in this era, the use of android-based technology in everyday life is inevitable [101]. Game-based learning media is designed based on the assessment results of children, this application can be accessed via smartphone/tab. This learning media contains teaching videos, practice questions, and games. Table 5 shows that the learning material in question is in the form of standard units of length, weight, and time.

The development of learning media developed in this study is based on the results of student assessment and analysis of their potential. This learning media is

designed using game-based learning technology with procedures for use as in Fig. 9. The design of game-based learning media is based on the results of needs analysis and the results of theoretical analysis.

Table 5. Standard unit material.

No.	Long	Weight	Time
1	Determine the name and function of length-measuring instruments	Determine the name and function of weight-measuring instruments	Recognize units of time, for example: seconds, minutes, hours, days, weeks
2	Using length measuring instruments	Using weight measuring instruments	Identify the time after and before an event takes place.
3	Solve story problems using length measurement tools	Solve story problems using weight measurement tools	Comparing the time duration of events that take place simultaneously.
4	Identify relationships between units of length (km, hm, dam, m, dm, cm, etc).	Identify relationships between units of weight (kg, ounces, dozen, gross reams)	Solve problems related to measuring time in seconds or hours
5	Converting inter-unit lengths to other inter-unit shapes	Converting between units of weight to other forms of units	Present problem-solving related to measuring time in seconds or hours
6	Solving story problems	Solving story problems	Read time marks to five minutes on an analog clock hand
7	Solving story problems	Solving story problems	Read digital clocks (hours, minutes, seconds).
8	Solving story problems	Solving story problems	Doing arithmetic operations on units of time
9	Solving story problems	Solving story problems	Working on story problems

The flowchart in Fig. 10 illustrates the flow of using game-based learning. This application consists of three major materials namely units of length, weight, and time. The formulation is based on the results of student needs assessment and theoretical analysis that standard units are important to understand and master because they are related to daily life [102]. The flow in this game starts with the start button, on the initial page, a narration of the story will appear. Each level cannot be accessed by the child before the child completes the final evaluation stage on place value material. Each level is determined based on Bloom's cognitive theory, namely C1 remembering (see Table 6), C2 understanding (see Table 7), and C3 applying.

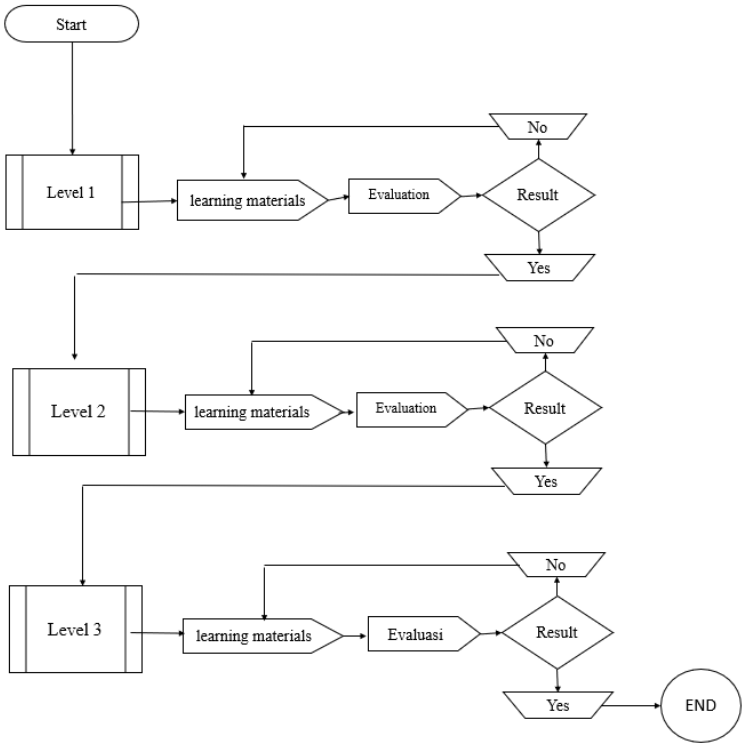


Fig. 10. Flow of game-based learning.

Table 6. Analysis of assessment results: level 1.

No.	Long	Weight	Time
1	The child is asked to name the length-measuring instrument.	The child is asked to name the weight-measuring instrument.	The child is asked to name the unit of time.
2	Children are asked to mention the function of length-measuring instruments.	The child is asked to mention the function of the weight-measuring instrument.	The child is asked to know how to read the time.
3	Children are asked to solve problems using length measuring instruments with semi-concrete picture examples.	Children are asked to solve problems using weight measurement tools with semi-concrete picture examples.	The child is asked to solve problems using units of time with semi-concrete picture examples.
4	The child is asked to name units of length into other units of length.	Children are asked to name units of weight into other units of weight.	Children are asked to name units of time into other units of time.

Table 7. Analysis of assessment results: level 2.

No.	Long	Weight	Time
1	The child is asked to complete the counting operation of length units (adding length units).	The child is asked to complete the counting operation of length units (adding weight units)	Children are asked to compare the duration of time based on the division of time in Indonesia
2	The child is asked to complete the counting operation of length units (subtracting length units)	The child is asked to complete the counting operation of units of length (subtracting units of weight)	The child is asked to complete arithmetic operations related to the measurement of time
3	The child is asked to complete the counting operation of length units (dividing length units)	The child is asked to complete the arithmetic operation of units of length (dividing units of weight)	The child is asked to complete arithmetic operations related to the measurement of time

Level 3 still uses Bloom's taxonomy (C3). Level 3 consists of 3 material coverages including units of length (the child is asked to solve problems involving various units of length), weight (the child is asked to solve problems involving various units of weight), and time (children are asked to solve problems related to time measurement).

4.3. Learning media design

This game-based learning media is designed like video games with rewards in the form of war games. Students have a consistently positive attitude towards game-based learning in mobile devices, students consider the learning experience to be more fun and interesting [31]. This game-based learning has a storyline of a village attacked by monsters named *meteridon, gramoti,* and *timerton*. The main role in this game is named *amodeus* who has a desire to get rid of monsters from his village. *Amodeous* will go on an adventure to find weapons that will be used against *Meteridon, Gramoti, and Timeron*. There are 3 hidden weapons at the end of the stage and every child completes 3 levels of each material. These weapons can be used to fight *Meteridon, Gramoti,* and *Timeron.*

The development of this learning media is based on the results of children's needs in the assessment analysis. Table 8 describes the learning media with the theme of war. This theme is determined based on children's high interest in war games. The content in this game-based learning consists of 3 levels with material on units of weight, length, and time. Each level is determined based on Bloom's cognitive theory, namely C1, C2, and C3. In the latest version of Bloom's taxonomy, the cognitive process dimension has six processes ranging from the simplest to the most complex, namely remembering, understanding, applying, analysing, evaluating, and creating. Students need to complete each level to access the next level.

Table 8. Learning media development.

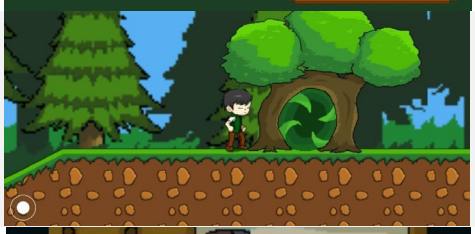
No.	Game-based learning media application	Description
1		The initial display of game-based learning media.
2		After selecting the start button, the main character in this game will appear. The character is directed to enter the portal in the tree image.
3		The in-game narrative here comes with the problem of monsters being disturbed by houses
4		After the narration in the game is complete, a practice option will appear to watch the learning video at level 1.
5		Learning material at level 1
6		After completing the learning video material, practice questions will appear. In the practice questions, students must meet the minimum criteria of 70. if students cannot meet it, they will be directed to the learning video again

Table 8. (Continue). Learning media development.

No.	Game-based learning media application	Description
7		If students can complete the evaluation more than the minimum criteria (70), they will get a reward in the form of weapons to defeat monsters.
8		After getting a weapon to knock out monsters, a narration will appear for the main character to use the weapon.
9		Students will direct the main character to use his weapon to defeat the monsters.
10		After defeating the monster, a narration will appear for students to continue the material and evaluation at level 2. This storyline will repeat itself at each level, the only difference being the depth of the material and the difficulty of the evaluation.

4.4. Reflection in learning media

The reflection results of this learning media development showed that students' skills in place value and counting operations increased. The improvement in skills is evidenced by the test results before using the learning media and the test results after using the learning media. Table 9 shows the ability of students before using learning media. In the latest version of Bloom's taxonomy, the cognitive process dimension has six processes ranging from the simplest to the most complex, namely remembering, understanding, applying, analysing, evaluating, and creating. Students' abilities in this study use Bloom's cognitive, namely remembering (C1), understanding (C2), and applying (C3) [103]. The research results showed that students' abilities in C1 were 66.6%, C2 were 49.96%, and C3 were 0%. Specifically, the average ability of students in length units is 47.2%, weight units 36.1%, and time units 33.3%

Table 9. Student abilities before using game-based learning media.

No.	Material	Skill			Average score
		C1	C2	C3	
1	Unit of length	75%	66.6%	0%	47.2%
2	Unit of weight	75%	33.3%	0%	36.1%
3	Unit of time	50%	50%	0%	33.3%
	Total score	66.6%	49.9%	0%	
Average total score			**33.8%**		

Table 10 explains students' abilities after using game-based learning media. This ability measurement uses Bloom's cognitive, namely remembering (C1), understanding (C2), and applying (C3) [103]. The results showed that students' ability in C1 was 100%, C2 was 72.2%, and C3 was 100%. This paper also adds new information in the education, as reported elsewhere [104, 105].

Table 10. Student abilities after using game-based learning media.

No.	Material	Skill			Average score
		C1	C2	C3	
1	Unit of length	100%	100%	100%	100%
2	Unit of weight	100%	66.6%	100%	88.8%
3	Unit of time	100%	50%	100%	88.3%
	Total score	100%	72.2%	100%	
Average total score			**90.7%**		

5. Conclusion

The goal of this research is to create instructional games and learning materials based on the SI for students with mathematics learning problems. These will be created utilizing Android-based technology. DBR is the research methodology used in this study to gather detailed data for the analysis of students with mathematics learning problems and the foundation for creating game-based learning resources. Students with mathematics learning problems in SI materials served as the study's subjects. The creation of instructional games and learning materials on SI content for kids with learning challenges in mathematics is the outcome of this work. The educational games and learning media content have been modified to meet the needs of kids with learning difficulties using SI materials. The content of game-based learning is specifically designed to meet the needs of students in SI. The findings demonstrated how learning requirements for SI content can be enhanced by educational gaming media. It is anticipated that other kids who are studying arithmetic with SI materials will also find use for this instructional game learning medium, in addition to kids with special needs.

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