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DESIGN OF AR-BASED MODULE IN NUMBER SENSE LEARNING TO IMPROVE SOCIAL INTERACTION SKILLS OF AUTISTIC STUDENTS

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Abstract

This study aims to assess the efficacy of module with augmented reality (AR) in number sense material in improving the social interaction skills of autistic children in regular kindergarten in East Java. The research method was the design-based research (DBR) to build and develop the design based on the research need. Data was gathered by observing the child's social interaction abilities, and pretest and posttest evaluation. The data analysis using the N-gain to compare the results the study's results indicated that implementing a E-module with AR positively impacted autistic children's social interaction and number sense learning. AR-based module facilitates intellectual pursuits and is based on the sustainable development goals (SDGs), enabling children to active and access the accessible learning material while ensuring a comfortable learning experience. This enables the utilization of children's communicative abilities within educational, communal, and family settings.

Keywords: Augmented reality, Autistic, E-Module, Number sense, Social interaction.

1. Introduction

The integration of learning modules with number sense topics for autistic students necessitates modifications to learning environments, particularly with technology such as augmented reality (AR). When considering the spread of quality education that is based on sustainable development goals (SDGs) challenges associated with identifying learning environments, it is possible to construct sensory aids, such as those related to vision, hearing, and perception, specifically tailored for young children with disabilities [1].

The use of technology integration, especially augmented reality in learning is important because of the need to provide interesting learning for students and effective ways of teaching for teachers and parents [2, 3]. Augmented reality is proven to affect students' learning motivation. Through this media, students can get a more real visual learning experience and affect the improvement of students' abilities [4]. Self-development can be seen in terms of engagement, persistence, motivation, attention, and curiosity, which also develops as learning can be accepted easily and enjoyably by students, this is especially relevant to social and academic interaction skills [5]. The increase in social interaction factors is indicated by student interest in learning content, students learn without feeling burdened, students can solve problems, this is also related to the development of other cognitive abilities so such as number sense skills where early autistic students are proven to be able to more easily understand the context of simple calculations through more attractive media and greater engagement as mentioned in the Table 1.

Table 1. Previous research.

No.	Title	Ref.
1.	Enabling technology integrated learning for autistic children using augmented reality based cognitive rehabilitation	[3]
2.	Use of augmented reality with a motion-controlled game utilizing alphabet letters and numbers to improve performance and reaction time skills for people with autism spectrum disorder	[6]
3.	The impact of applying augmented reality technology in learning on student learning experiences	[7]
4.	Digital natives come of age: the reality of today's early career teachers using mobile devices to teach mathematics	[8]
5.	Teaching mathematics with mobile devices and the realistic mathematical education (RME) approach in kindergarten	[9]

The objective of this study is to assess the implementation of AR-based number sense learning module design in SAM (Science, Art, Math) for improving social interaction within the regular kindergarten settings in East Java. The novelties in this study include the (i) AR-based module, (ii) integration of the number sense topic and the design impact to autistic social interaction, (iii) focused on early childhood year. This study presents a novel methodology for enhancing the social interaction abilities of early childhood autism in regular kindergarten settings through AR-based SAM (Science, Art, Math) number sense learning module design. The proposed strategy involves the integration of the utilization of AR-based learning module resources in number sense and how students can comprehend and react to the instruction.

2. Literature Review

2.1. AR-based learning module

Learning Module with Augmented Reality (AR) is a medium that applied a digital form of a module parts such as pictures, sounds, and other sources into augmented content [10, 11]. With this interesting medium, teachers can evolve the educational practices with enhancing engagement with the class [7, 12, 13]. Students will have the longer attention span and focused learning. Teachers use this module to explain the concept better with the concrete appearance and real like experience [14-17]. This way students can easily understand about the learning purposes and can easily visualize the materials [18, 19].

2.2. Number sense

In the context of learning mathematical practices, students are taught to know about how to combine the symbol and calculation into a concept. Based on Fig. 1, phase of number sense is divided into three levels that are first level with the level of context-bound counting and calculating simple addition and subtraction.; second level, the level of object-bound counting and calculating simple addition and subtraction problems where the objects are displayed and then hidden; third level - the level of pure counting and calculating addition and subtraction using missing variables [8, 9]. This is also related to the problem-solving skills that attach to the other skills development. Through AR-based module approach students might be easily understand than they have to just explicitly a book.

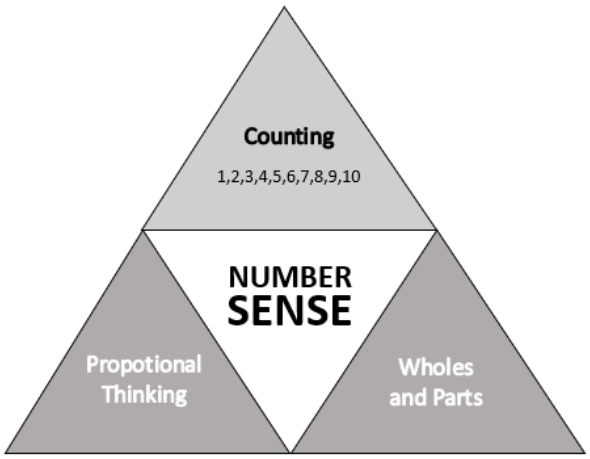

Fig. 1. Number sense concept.

2.3. Autistic children

Autistic students have a specific impairment in their interaction and social communication. This leads to slower development in their social life and language. With this impairment, autistic students might face difficulties in a different and sudden change in their daily life. It usually marked with a different response in each condition. The need to get easily adapt and comprehend in each condition [20].

Autistic children often face difficulties in adapting to different social environments and often respond inappropriately to situations. Adaptation and understanding of different situations are very important for them. The existence of a spectrum that gives rise to a wide variety of autistic characteristics in children, distinguishes them from individuals with other disabilities, while social interaction remains a major challenge due to their difficulties in providing appropriate responses and understanding emotions and empathy in their social context, with understanding and diverse approaches can help them adapt and develop optimally in understanding their surrounding environment [21].

2.4. Social interaction skills

The importance to have social interaction skills is for predicting the challenges and also how to face them is an interaction between individuals. So that an individual can live in any circumstances with their ability to adapt [22, 23]. If a person has the lack of social interaction skills, they will struggle to address the way they comprehend and react to their environment. Which leads to social and behavioural problems in a person. Moreover, improving social interaction skills may positively affect the development of an individual [24, 25]. In conclusion, to conduct Augmented Reality (AR) based learning module in number sense introduction to autistic students is to encourage the students to work together that will improve the social interaction skills.

3. Method

This study uses design-based research (DBR) in four phases. The research has four phases, namely analysis, design, development, and evaluation. The analysis phase was used to analyse the needs of the learning module in number sense learning and bring it together with the needs of autistic students. Due to the analysed needs, the design phase was carried out by designing the augmented reality (AR) to be applied inside of the e-module, which has to be developed through the development phase by building the AR and making the module into the electronic module. In the iterative phase, a problem was found with the not-responding AR, which needs to be revised into a smoother version. Lastly, in the reflection phase, specialist validation was carried out, and the pretest and posttest were implemented in the group of autistic and regular kindergarten students at TK Happy Smart Kids.

4. Results and Discussion

The analysis stage carried out is through identifying problems from the learner profile. Autistic learners have a need to understand the material provided in written format. Therefore, supporting materials in the form of visuals that can be applied by autistic learners with or without a teacher are needed. Visuals with a touch of real experience are proven to be easier to understand, one of which is through video tutorial activities. This is also supported by interviews with teachers which resulted in the finding that autistic learners find it easier to receive material to be understood by seeing visuals of real activities, especially during distance learning which requires real and interesting experience tutorials for children. The analysis stage is carried out by identifying problems from the learner profile. Autistic learners have a need to understand the material provided in written format. Therefore, supporting

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Through this needs analysis, the concept of AR-based module design related to number sense was born, which is tailored to the needs of students. In Fig. 2, there is a flowchart related to the design of AR-based module learning. When opening the learning e-module, the full form of the e-module will be displayed and on the fourth page there will be learning steps in which AR-based videos will be provided which can be accessed through AR scan application and can display visuals in the form of real videos of how to pour dough.

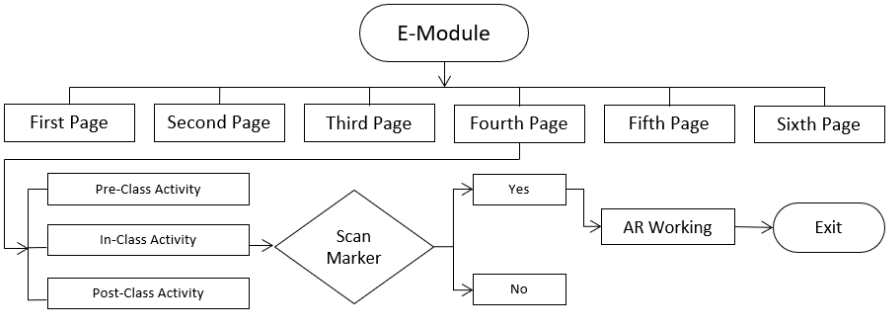

Fig. 2. AR-based e-module flowchart.

The results of this design go through the development phase in the form of a change in the previous tutorial in the form of a one-minute video of how to pour the dough in nine seconds with one pour of dough. This is considered to be the maximization of focus on one activity so that the results obtained from the video example can be more easily understood by autistic learners at an early age. Starting with opening the learning module, the learning stage is carried out by carrying out initial learning activities with students and continuing to the core learning activities in the form of learning how to cook Kue Cubit. At the pouring stage, the teacher shows the tutorial through AR scan application and AR-based videos to learners. Learners are asked to practice and count how many times the pouring is done and done alternately with their friends.

In the iterative process, several problems were found, including the AR scan application having errors on some devices. Devices that have little memory space, recorded more frequent errors than devices that have ample memory space. Errors that have occurred in the form of failing to open the application and when trying to close the AR scan application. The programmer who made the AR scan application finally reviewed this error. After that, the AR scan application can be run properly during the implementation stage.

Finally, the reflection stage is the stage of expert validation to educational technology experts to obtain assessment data in the form of whether or not the e-

module is feasible and check the effectiveness of the E-module containing AR tutorials in it. From expert validation, the average value of the aspects assessed based on the expert validation instrument is 4 out of 5, which means that the augmented reality-based Number Sense learning E-module design has a good category in its development. The results of the implementation of this AR-based e-module are obtained from the results of pre-tests and post-tests which produce conclusions in the form of effective categories as listed in Table 2. Finally, this study adds new information in virtual laboratory as reported elsewhere [26, 27].

Table 2. Differences in number sense and social interaction before and after using AR-based module.

Variable	Mean			Conclusion	
	Before	After	Difference	N-Gain %	Category
Number sense	1.85	3.87	2.02	94.44%	Effective
Social interaction	1.95	3.83	1.88	95.83%	Effective

5. Conclusion

This study aims to demonstrate the effective implementation of an AR-based learning module on number sense that has been conducted as a research initiative aimed at improving the number sense skills of children with autism difficulties in a regular kindergarten located in East Java. The use of this approach has resulted in a significant improvement in students' communicative abilities, as evidenced in the classroom setting. Furthermore, this phase of the study will include two main activities. Initially, the researchers will develop a preliminary scientific manuscript that includes the research findings, which will then be submitted to relevant international scientific publications. Next, the researchers will proceed with the preparation of a comprehensive research report covering the entire research process that has been conducted.

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