Hijaiyah Letter Interactive Learning for Mild Mental Retardation Children using Gillingham Method and Augmented Reality

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***Abstract*—Assistive technology for children with special needs is a problem that is interesting to study. Collaboration between methods and latest technology can be used as a learning aid for them. Learning of Hijaiyah letters is the first step to being able to read the Holy Qur'an. Mentally retarded children have IQs below the average normal child, so their learning process is slower and requires special methods. This study aims to develop an application by using the Gillingham and augmented reality methods to help mentally retarded children recognize Hijaiyah letters. The Gillingham method uses a visual, auditory, kinestetic, and tactile (VAKT) approach, that can be used to facilitate mentally retarded children. While augmented reality is used to develop more interesting and interactive applications. Based on the results of research and testing, it can be concluded that the learning application that was built can improve children's memory and understanding of Hijaiyah letters, The results of the pretest and posttest testing, showed an increase of 12% for children who were difficult to receive learning material and 6% for children who are classified as easy to receive learning material.**

***Keywords*—Hijaiyah; intercative learning; mild retarded child; Gillingham; VAKT; augmented reality**

I. Introduction

Children with mental retardation are children with limited conditions of development. The ability to learn is different from other normal children. Certain assistive methods and technologies are needed to support the teaching of children with special needs. This needs to combine the ability of special schools that handle mentally disabled children with assistive technology that can be used in learning [1].

The method that is widely used in helping children with special needs in letter recognition is the gillingham method. This method uses a multisensory mechanism to provide learning stimuli in the form of sounds, images and flavors to adapt the letters [2]. The Gillingham method is oriented to sound and letter links. Each letter is taught using a multisensory approach. Multisensory approaches used are visual, auditory, kinesthetic, and tactile (VAKT) [3]. Studies related to the VAKT approach have been carried out for children with special needs, such as the application of VAKT to deaf children [4], the application of VAKT to autistic children [5], and the implementation of VAKT in mentally disabled children [6].

The assistive technology used in helping children with special needs such as mental retardation is the development of hardware and software tailored to the abilities possessed by these children [7]. Other assistive technologies center on varied sound processing and displays [8], while other researchers reveal the use of assistive technologies that are self-management tools that are beneficial for mentally disabled people in completing their daily activities [9]. The mobile application is one of the potential solutions for the development of learning for children with special needs, this is shown in research on the use of palmtops for mentally disabled people [10], the MARBEL mobile application for letter recognition learning for mild mental retardation sufferers [11] and android-based motorbike games for mentally disabled children [12]. Due to the limitations of integensia in mentally disabled children, learning models that are more adaptive to their abilities are needed. The interactive learning model is a learning model that can stimulate many activities for mentally disabled children [13]. This learning model can appear in the form of game-based learning for mentally disabled people developed with the help of computers [14] to produce games for mentally disabled children. Other studies use interactive technology and MAS platform games to help improve learning for deaf children [15]. Educational games for caring for mentally disabled children have also been developed and used to train children's motor skills and can be used by teachers as one of the learning media. [16]. Mobile applications and Augmented reality become a potential in the development of learning [17]. Augmented Augmented reality moves to become one of the technologies that has the ability to be used as the basis for developing learning applications for children [18]. The application of augmented reality can also provide flexibility in giving learning strategies [19], and is able to increase student learning motivation [20] and for children with special needs [21]. Augmented reality can also be used as a therapeutic medium for mentally disabled patients [22]. Other studies [23] show that augmented reality can help autistic patients and mentally disabled children to navigate to find a particular location / place.

The use of the VAKT method in this study aims to improve the ability of mildly retarded children in Hijaiyah letter learning. This study also aims to map the VAKT method to technology that allows for the development of interactive multimedia learning media by utilizing augmented reality

technology, with the hope that the application developed can stimulate the visual, auditory, kinesthetic, and tactile senses of mildly retarded children so that they can easier to recognize and learn the letters Hijaiyah. In this study, the application will be tested on 2 groups of mild mentally retarded children to find out the changes in the ability of these children in Hijaiyah letter learning after using the application.

II. Research Method

The research method used in this research is divided into 4 stages, namely:

- The researcher collects the initial data according to the needs with a literature study in the form of journals and books related to the research that will be conducted. After the data is sufficient to support the research, the researcher will prepare the tools and materials needed for the next stage.
- At the planning stage, researchers make modeling applications that want to be made. The modeling started with system description, system architecture, functional analysis of application until application interfaces design.
- At the development stage, researchers will develop a model that has been made previously in the form of a program that is ready to be tested.
- The last stage is implementation and testing, the researcher implements the application on the appropriate device and tests how feasible the program has been made to be applied to mild mentally retarded children.

III. Result and Discussion

This section describes the analysis of the current learning conditions, the application architecture developed, mapping the Gillingham method with the VAKT approach to the application developed, system modeling, design and testing of application built.

A. Analysis of Current Learning Conditions

From observations and interviews conducted by researchers, it was concluded that the current learning conditions still use conventional methods, namely teachers teaching students using ordinary teaching equipment and textbooks. Current procedures for teaching activities can be seen in Fig. 1 and 2.

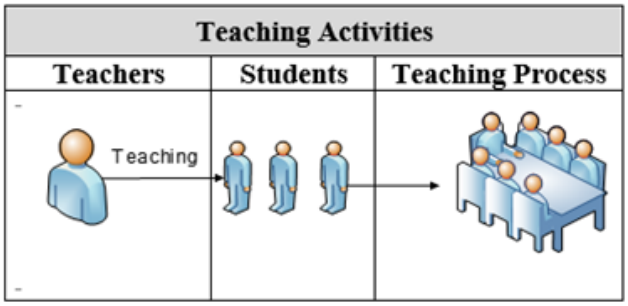


Fig. 1. Current Teaching Activity.

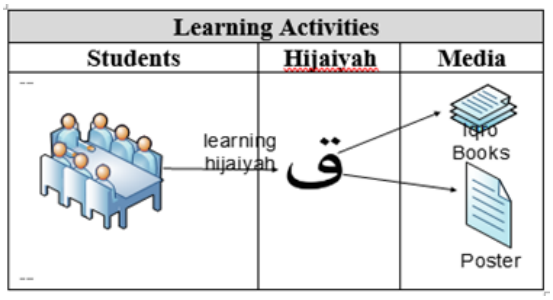


Fig. 2. Current Learning Hijaiyah Activity.

B. Description of the Application

The interactive learning Hijaiyah is a mobile-based application that is specifically for mild mentally retarded children learning Hijaiyah letters, with a structured and oriented method on sound and letter links. Where each letter is studied multisensory, starting from the sound, tracing the letters and copying letters. This learning method is called the Gillingham method. The VAKT Approach In this application is by introducing the Hijaiyah letters visually, with the help of sounds and images and thickening the letter points (movements) that have been taught. Each letter must be completed in order to proceed to the next letter. This application is made by using specific learning principles for mentally retarded children such as repetition and directed and gradual system flow. Augmented reality with marker frames is used to attract children to learn in more interesting ways. The application description that will be built can be seen in Fig. 3.

C. Analysis of System Architecture

The system architecture is an overview of the application to provide the initial model of the application to be built [24] [25]. The system architecture that is built consists of several components of learning material presented with several modalities. The modalities used are visual (vision), auditory (hearing), kinesthetic (movement), and tactile (touch). The four are known as VAKT. System architecture in the development of this application introduces and teaches Hijaiyah letters to train children's memory with VAKT modalities- he Gillingham method, which is shown in Fig. 4.

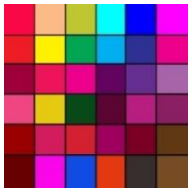
The next step is to synchronize the Gillingham - VAKT method into the application that was built. Table I explains how the mapping of the Gillingham-VAKT method to the application was built.

D. Analysis of Learning Outcomes

The application that is built has a feature to store learning data in the form of student report cards. Student report cards will show the level of success of students in learning the material contained in the application. The student report card shows the number of correct answers and how many times the student is doing repetitions. Fig. 5 shows the student report card model in the application.

The learning results obtained by students are the values from the guessing feature and writing the letters Hijaiyah. Table II explains the calculations for the assessment of answers.

TABLE I. IMPLEMENTATION GILLINGHAM METHOD ON APPLICATION

Gillingham	Application
Visual **(**Learning by seeing**)** Here, which plays an important role is the senses or vision (visual). This type of student gate of knowledge is the eye, because the only senses that are active and dominant in him are the eyes or vision.	1. Showing letters in a structured and focused on one-on-one letter ا ب ت ث ج ح خ د ذ ر 2. Atractive Colors  3. Animation for ways of writing letter 
Auditory **(**Learning by listening**)** Auditory type students rely on their learning success through their ears (hearing aids), for that teachers should pay attention to their students to their hearing aids. Students who have auditory learning styles can learn faster by using verbal discussion and listening to what the teacher says.	4. Audio that appears at each stage of learning that explains and teaches by repeating each letter. 5. Audio that shows how to use the application  6. Audio encorage and motivate children to study harder
Kinesthetic **(**Learning By Means of Physical Movement**)** Students who have kinesthetic learning styles how to learn always respond to every lesson received with physical movement. He also prefers the lessons given in the form of games because basically he cannot sit and stay long while studying.	7. Application of learning by inviting users to participate interact during the learning takes place to make the application more interactive. 8. In game card magic users need to use the phone in order to scan the card. The learning process is to train movements and memory of children. 
Tactile **(**Learn by Touch**)** Students who study this type, which plays an important role is feeling and touch. Students like this get the results of their learning through touch devices, namely the touch of their hands or skin.	9. The process of learning is presented with a smartphone and all of the learning process presented by touching the screen smartphone 10. At this stage of learning to write letters the user must browse and thicken dots that form the letter Hijaiyah 

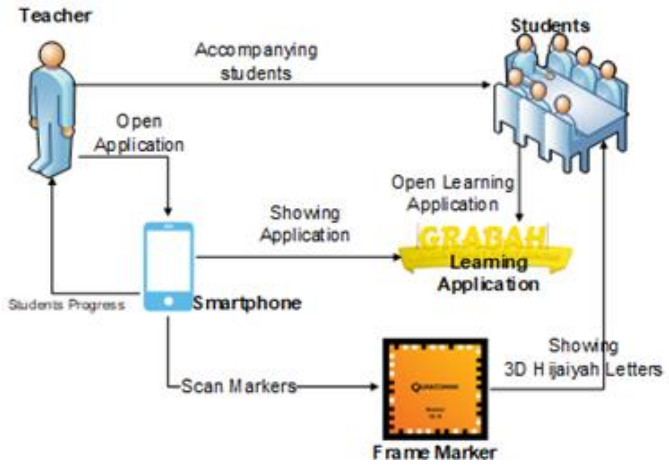


Fig. 3. Description of Application.

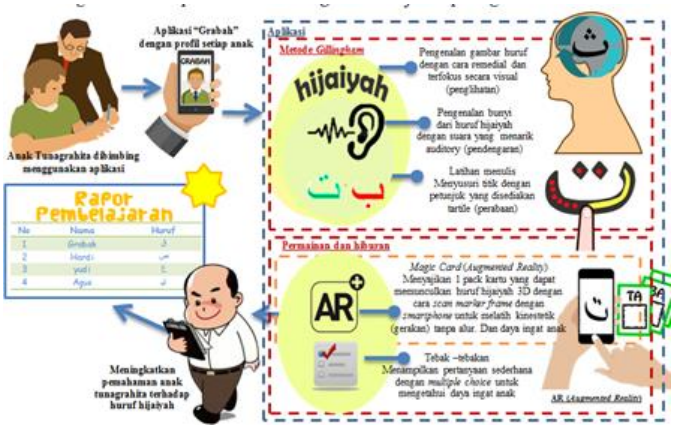


Fig. 4. System Architecture.

Fig. 5. Student Report Cards.

TABLE II. LEARNING SCORING

Stages of Learning	Number of Correct Answers	System Action
Quiz Multiple choice	Answer correctly two times	Continue to the stage of learning write Hijaiyah
Write Hijaiyah	Answer wrong 3 times	Repeating steps of learning to write Hijaiyah

Wrong answers are limited to three times. Checkpoints are obtained from up to Hijaiyah letters that are open or understood and stored in student reports. In the report feature there will be a value in the form of numbers and last letters of the Hijaiyah that have been studied by each student.

E. Analysis of Augmented Reality

Augmented Reality is a real-time direct or indirect view of a physical real-world environment that has been enhanced/augmented by adding virtual computer-generated information to it. Its aims at simplifying the user's life by bringing virtual information not only to his immediate surroundings but also to any indirect view of the real-world environment [26]. The application built on Android, which has a feature to scan markers of Hijaiyah letters to produce an output in the form of a 3D object from the letters of the Hijaiyah. The flow of application of augmeted reality in the application that was built, can be seen in Fig. 6.

Augmented reality developed in this application uses marker-based methods. The markers used are in the form of a collection of Hijaiyah letters card as shown in Fig. 7 and poster of the Hijaiyah letters in Fig. 8.

The markers will be scanned by the application to produce a 3D form of the letter Hijaiyah. The 3D model that appears is made tilting 130 degrees to adjust the user's eye. In Fig. 9, a 3D model is displayed that will appear from the scanned marker card.

The 3D model will also appear when the Hijaiyah letter poster is scanned using a built-in application. The 3D model that appears on the line aligns with the marker adjusting the user's eye point of view. Fig. 10 illustrates the appearance of a 3D model that will appear from the poster marker.

Fig. 6. Implementation of Augmented Reality.

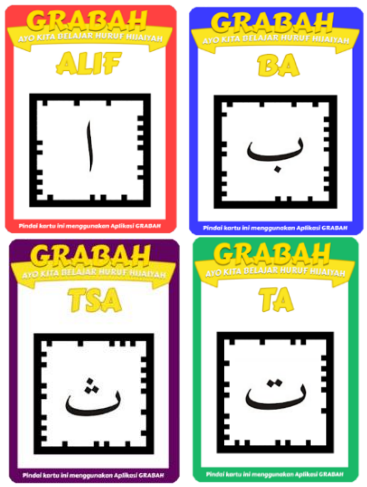


Fig. 7. Hijaiyah Letters Card Marker.

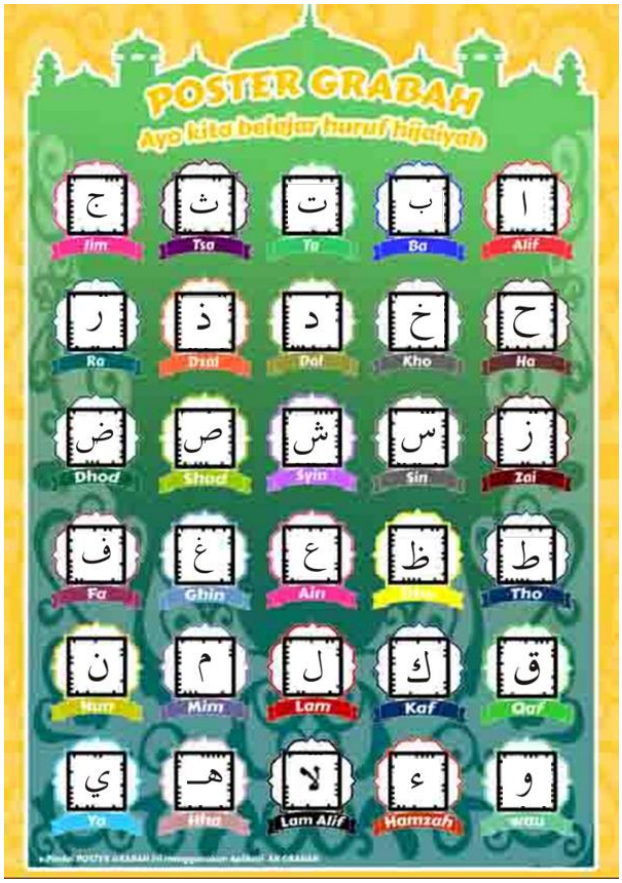


Fig. 8. Hijaiyah Letters Poster Marker.

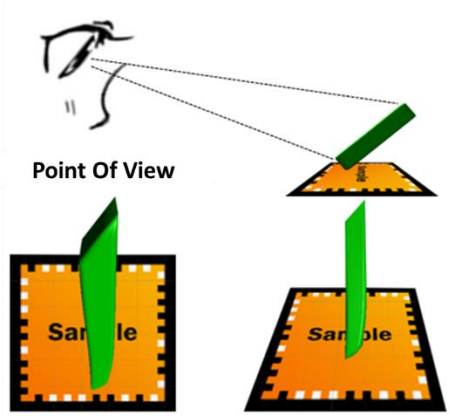


Fig. 9. 3D Model Display Card Hijaiyah Augmented Reality.

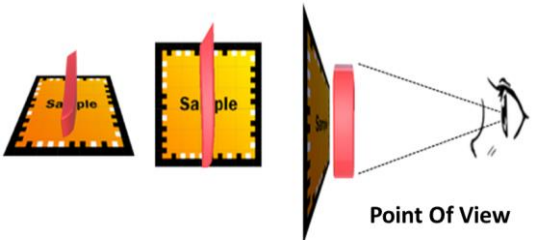


Fig. 10. 3D Model Display Poster Hijaiyah Augmented Reality.

F. Data Store Analysis

Data storage in this application uses Playerprefs. Playerprefs is a database contained in the Unity application that can be used to store various kinds of data. In this application, playerprefs is used to store application user data, such as student names, letters that have been studied, and scores obtained by each student. Data storage workflow can be seen in Fig. 11.

G. Application Modeling

Modeling application used to facilitate the functional description that will be included in the application [27]. Application modeling is built using a use case diagram to explain the functional requirements contained in the application. Fig. 12 shows the use case diagram of the application that was built, as well as the description of each functional which can be seen in Table III.

H. Annimation Design

Animation is a motion picture that is formed from a set of objects (images) arranged regularly following the flow of motion that has been determined based on time [28]. The animation design applied in this application is to illustrate the animation of application characters as seen in Fig. 13, and animation for Hijaiyah letter movements in the application.

Animation in Hijaiyah letters is done by using the Tracking Point method where dots placed above the Hijaiyah letters are useful as a guide for writing Hijaiyah letters, as seen in Fig. 14.

Fig. 11. Playprefs Data Storage.

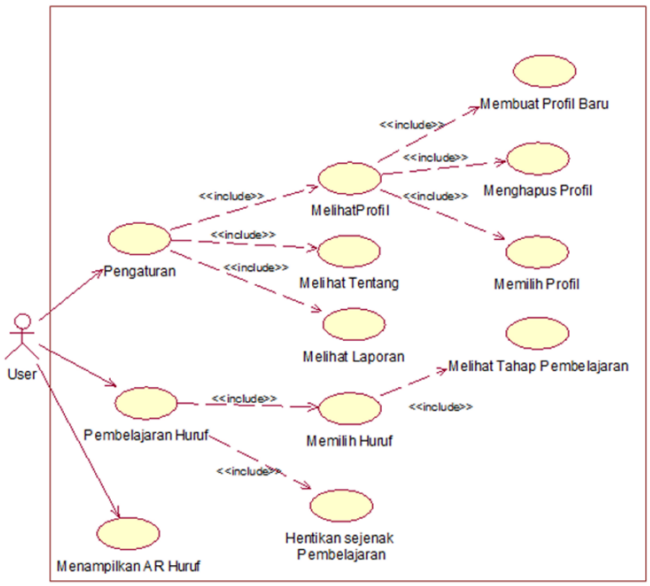


Fig. 12. Use Case Diagram Application.

TABLE III. USE CASE DEFINITIONS

No	Use Case Name	Description
1	Pengaturan	The functionality is to go see the profile settings, look about and see the learning report.
2	Membuat Profil	A functionality to create user application with a new profile
3	Menghapus Profil	A functionality to delete a profile that was made before
4	Memilih Profil	A functionality for to determine which profile is active
5	Melihat Profil	A functionality for anyone to see the profile name or an existing child
6	Melihat tentang	Is the functionality to view information about the application maker
7	Melihat laporan	Is the functionality to see the extent to which the child has been studying Hijaiyah
8	Pembelajaran huruf	Functionality is to introduce the Hijaiyah
9	Memilih huruf	Hijaiyah functionality is to choose which one will be studied. Could continue from last Hijaiyah learned or repeat Hijaiyah has been learned.
10	Memilih tahap pembelajaran	A functionality to choose from where the checkpoint will repeat. From each chekpoint consists of 5 letters Hijaiyah.
11	Hentikan sejanak pembelajaran	A pause functionality for learning and there is a menu to get to the home page and the music setting.
12	Menampilkan AR huruf	Is the functionality to display the augmented reality feature or magic playing cards.

The tracking point method is used to animate Hijaiyah letters to show how to write the correct Hijaiyah letters. One example of the animation of Hijaiyah letters can be seen in Fig. 15.

Fig. 13. Illustration of Character in Application.

Fig. 14. Hijaiyah Letters Tracking Point Design.

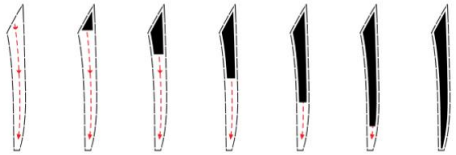


Fig. 15. Animated Hijaiyah Letters.

TABLE IV. MAPPING POINTS HIJAIYAH LETTERS

Hijaiyah Letter	Number of Points	Position (x,y,z)

Alif ا	10 points	point[0] position(-8,229,0);
		point[1] position(-3,190,0);
		point[2] position(-1,150,0);
		point[3] position (2,103,0);
		point[4] position(5,63,0);
		point[5] position(6,17,0);
		point[6] position(7,-29,0);
		point[7] position(6,-73,0);
		point[8] position(4,-115,0);
		point[9] position(1,-160,0);

Ba ب	13 points	point[0] position(164,143,0);
		point[1] position(183,100,0);
		point[2] position(180,54,0);
		point[3] position(150,24,0);
		point[4] position(95,6,0);
		point[5] position(29,-4,0);
		point[6] position(-30,-8,0);
		point[7] position(-83,-7,0);
		point[8] position(-138,4,0);
		point[9] position(-181,34,0);
		point[10] position(-193,84,0);
		point[11] position(-185,124,0);
		point[12] position(10,-144,0);

Ta ت	13 points	point[0] position(162,138,0);
		point[1] position(186,84,0);
		point[2] position(167,34,0);
		point[3] position(117,9,0);
		point[4] position(59,-5,0);
		point[5] position(0,-12,0);
		point[6] position(-59,-14,0);
		point[7] position(-115, -8,0);
		point[8] position(-163, 9,0);
		point[9] position(-192,51,0);
		point[10] position(-188,116,0);
		point[11] position(48,188,0);
		point[12] position(-37,189,0);

With the tracking point method used, each Hijaiyah letter is mapped into points which later become a marker for the animation movement on the letter. Examples of mapping these points can be seen in Table IV.

I. *Implementation and Testing*

The final result of this study is an interactive learning application for mild mentally retarded children where the design application uses the VAKT approach and augmented reality. Some application interface can be seen in Fig. 16, 17, 18 and 19.

Fig. 16. Application Opening Interface.

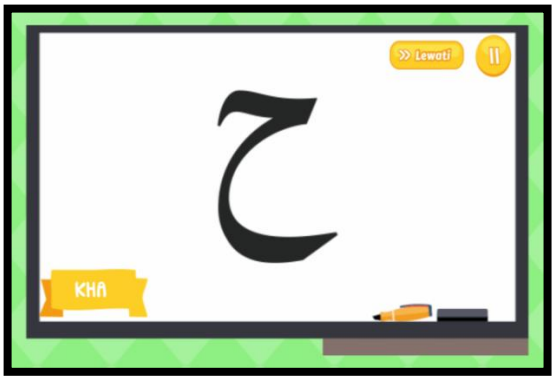


Fig. 17. Hijaiyah Letter Introduction.

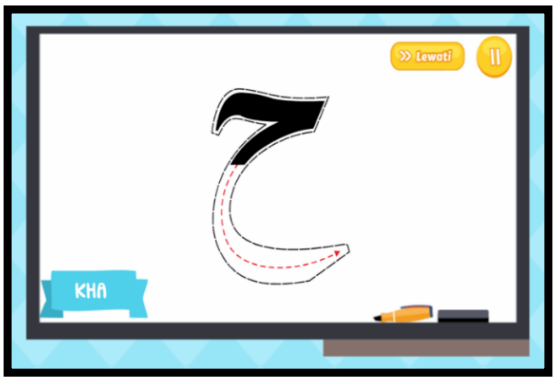
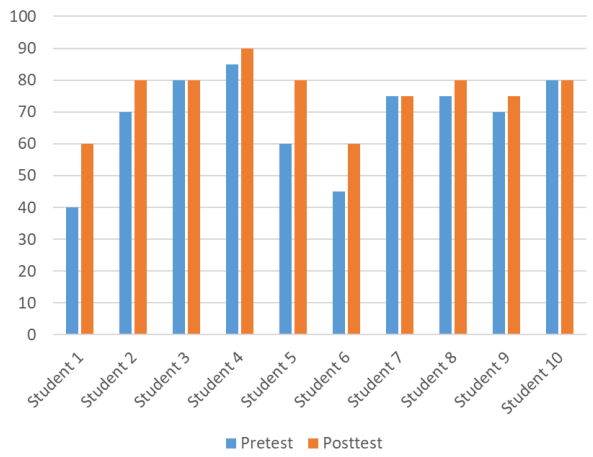


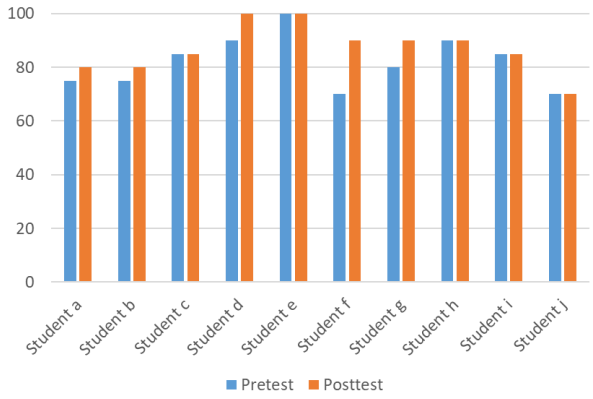
Fig. 18. Drawing Hijaiyah Letter.

Fig. 19. Game the Correct Letters.

Application testing is conducted in two ways, namely, testing the accuracy of the marker used, and testing the ability of students using the application. The results obtained from the marker-augmented reality test concluded that from 30 markers of Hijaiyah letters in the form of cards and posters, 100% of the markers can be scanned and produce 3D objects Hijaiyah letters. Testing students' abilities, using the pretest and posttest method. The pretest method is used to measure students' abilities before using the application, while the posttest method is used after students use the application. Application testing is carried out on 20 students divided into two groups, namely, students who have difficulty concentrating and students who are easy to concentrate. The results of the pretest and posttest tests on students who have difficulty concentrating can be seen in Fig. 20(a), while the results of testing for students who are easy to concentrate can be seen in Fig. 20(b).



(a)



(b)

Fig. 20. Pretest and Posttest Results.

From the results of these tests, the average is calculated to determine changes in students' abilities before and after using the application, shown in Table V.

The results of the research conducted gave results of improvement in both test groups of mild mentally retarded children. Children who have difficulty concentrating have increased by 12%, while for children who are easy to concentrate, there is a 6% increase in Hijaiyah letter learning. Likewise with the results of previous studies that by using multisensory-VAKT methods, there is an increase in the learning of children with special needs, in the study [29] the reading ability of kindergarten students increased by 14%, in the other study the reading ability of elementary students with dyslexia increased in the number of word recognition, reading time, and the number of words read per minute [30], and the development of the ability to recognize flat waking in children with cerebral palsy increased with a percentage of 66.6% [31].

TABLE V. RESULTS AFTER USING THE APPLICATION

Children Group	Pretest Average	Posttest Average	Increase Score	Percentage (%)
Difficulty concentrating	680/10 = 68	760/10 = 76	8	12%
Easy concentrating	820/10 = 82	870/10 = 87	5	6%

IV. CONCLUSIONS

Based on the results of the implementation and testing carried out, it can be concluded that the Gillingham method with the VAKT approach and augmented reality can be developed into an interactive learning application that is able to improve the ability of students with mild mental disabilities. This is indicated by an increase in capacity of 12% for students who have difficulty concentrating and an increase of 6% for students who are easy to concentrate on the material and learning Hijaiyah letters.

For further work, it is necessary to consider other technologies in developing the application in the future, mapping the VAKT method that is more varied in order to produce more diverse learning variations that are in accordance with the ability of children with mild retardation.

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