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DESIGN AND DEVELOPMENT OF EDUCATIONAL GAMES FOR AUTISM PATIENTS BASED ON AN EXPERT SYSTEM

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***Abstract*— Reporting from repository.kemdikbud.go.id, the number of Children with Special Needs (ABK) in Indonesia reached 144,621 (0.47% of total children in Indonesia), with 889 children with autism (0.003% of total children in Indonesia). Autistic disorders are increasing every year in the world, as well as in Indonesia.**

The method for teaching autistic children is a combination of methods whose application is adapted to the child's condition and abilities as well as the teaching material given to the child. So that the game can be played by autistic children, it is necessary to adjust the game's difficulty level.

Based on the explanation above, an Android application was created that can support autistic children in school. The forward chaining method is suitable as a method for summarizing children's playing results, where the levels in this game will be divided into 3 according to their abilities.

Keywords—Education Game, Expert System, Autistic Children

I. Introduction (*Font 14*)

Based on data from the Ministry of Home Affairs in 2021 through the Directorate General of Dukcapil [1], the population in Indonesia reached 273,879,750 people, while the number of young children is estimated at 30.83 million people, equivalent to 11.3% of Indonesia's total population.

Reporting from repository.kemdikbud.go.id [2], the number of Children with Special Needs (ABK) in Indonesia reached 144,621 (0.47% of total children in Indonesia), with 889 children with autism (0.003% of total children in Indonesia). Autistic disorders are increasing every year in the world, as well as in Indonesia.

Autism is a pervasive developmental disorder in children which is characterized by disturbances and delays in the areas of cognition, language, behavior, communication and social interaction. Autistic children can go to school with other general students, one of which is an inclusive school.

Inclusive schools are a metamorphosis of human culture. That every human being is the same, has the same rights and the same opportunities to develop and obtain education for the continuation of a better life. Inclusive education is an effort to eliminate obstacles for students and at the same time increase opportunities for education for everyone, including students with special needs. [3] (Asiyah, 2018)

Learning adjustments used for children with autism in inclusive schools include lectures, questions and answers, discussions, demonstrations, role playing, field trips and so on. The method for teaching autistic children is a combination of methods whose application is adapted to the child's condition and abilities as well as the teaching material given to the child.

Educational games are a tool so that someone can learn through game media. Educational games are a learning media that is educational in nature, where this media can encourage students to think creatively and carry out activities with fellow students in playing games in learning activities. Educational games for autistic children are learning specifically for autistic children, both in terms of theme, appearance, curriculum, and so on. So that the game can be played by autistic children, it is necessary to adjust the game's difficulty level.

Several sources have conducted research related to educational media for autistic children and there is also research related to the diagnosis of autistic children, but

there are still several parts that can be developed and collaborated between one research and another. Research [4] conducted by Pramudita Wanti Andari (2019) aims to improve reading comprehension skills through giving rewards to autistic students in class VI at SLB Darma Putra Gunungkidul. The results of the research show that the use of rewards can improve reading comprehension skills in autistic students. This increase was obtained from the results of providing rewards in the form of verbal and non-verbal praise and playing games at pre-agreed times. What can be developed in this research is providing rewards in educational games.

In a journal [5] written by Fikri (2018), he created an educational game for autistic children based on Android that can be implemented and is useful for schools. In a journal [6] written by Robi Naufal Kaosar (2021), he created an educational game using an expert system to determine the level of difficulty, with learning material for reading and arithmetic.

Based on the explanation above, an Android application was created that can support autistic children in school. The forward chaining method is suitable as a method for summarizing children's playing results, where the levels in this game will be divided into 3 according to their abilities. This game is a development of previous research conducted by Robi (2021), so there is learning material for reading, writing and arithmetic.

This game uses an expert system, which is a computer system that can match or imitate the abilities of an expert. Expert systems are able to retrieve, store and preserve the knowledge and expertise of experts (especially those with rare expertise. Starting from producing a description of the situation, estimating the consequences of a given situation, drawing conclusions, and planning the actions to be taken.

II. Research Methodology

A. Data Collection Technique

The research will be carried out at Campus 2 of the Ujung Pandang State Polytechnic and Special Schools or schools that have inclusion pathways in Makassar. The research will be carried out in the period 3 February to 3 July 2023.

In order to produce research results that are in accordance with the research objectives, it is necessary to carry out a good research planning stage through the research stage. The stages in this research are shown in Figure 3.1 below.

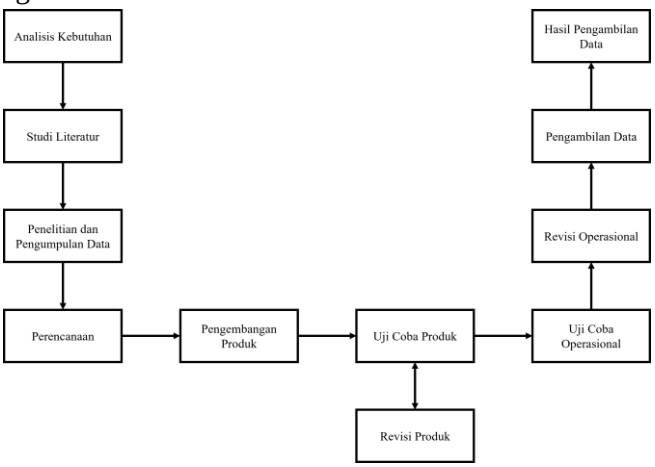


Figure 1. Research Phase

1) Needs analysis stage, analyzing the tools and materials that will be used in the research.
2) The literature study stage is obtained from various available sources such as journals, theses, books, websites and other sources that are related to the problems being faced.
3) The data collection stage consists of material needs analysis, user analysis, and tool and material analysis.
4) The planning stage consists of flowcharts and activity diagrams.
5) The product development stage uses the DDD-E method (Decide, Design, Develop, Evaluate).
6) The product testing stage uses black box testing.
7) If during the product testing stage there are bugs and/or features that have not been created, then a product revision stage will be carried out. This stage will continue as long as there are still bugs or missing features during product testing.
8) If the product testing stage is deemed safe, the next step is the operational testing stage, which involves experts to carry out trials on this software.

9) Operational revision stage to fix bugs or add other features based on input from experts to improve this software.
10) The data collection stage was carried out in the field with the aim of collecting data based on a predetermined sample, namely autistic students in special schools at elementary school level grades 1-3.
11) The data collection results stage consists of data processing and report preparation.

B. System Planning

This is the early phase of the process of designing and creating educational games for autistic children. This phase will explain the application specifications in detail.

1. Procedural Design

Procedural design is needed in design planning to explain and provide an overview of the sequence and work flow of each function in the application.

a. Flowchart

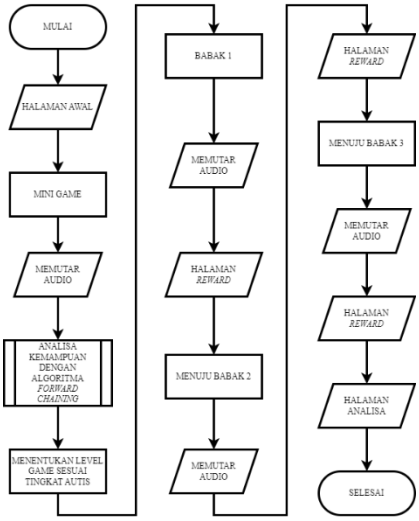
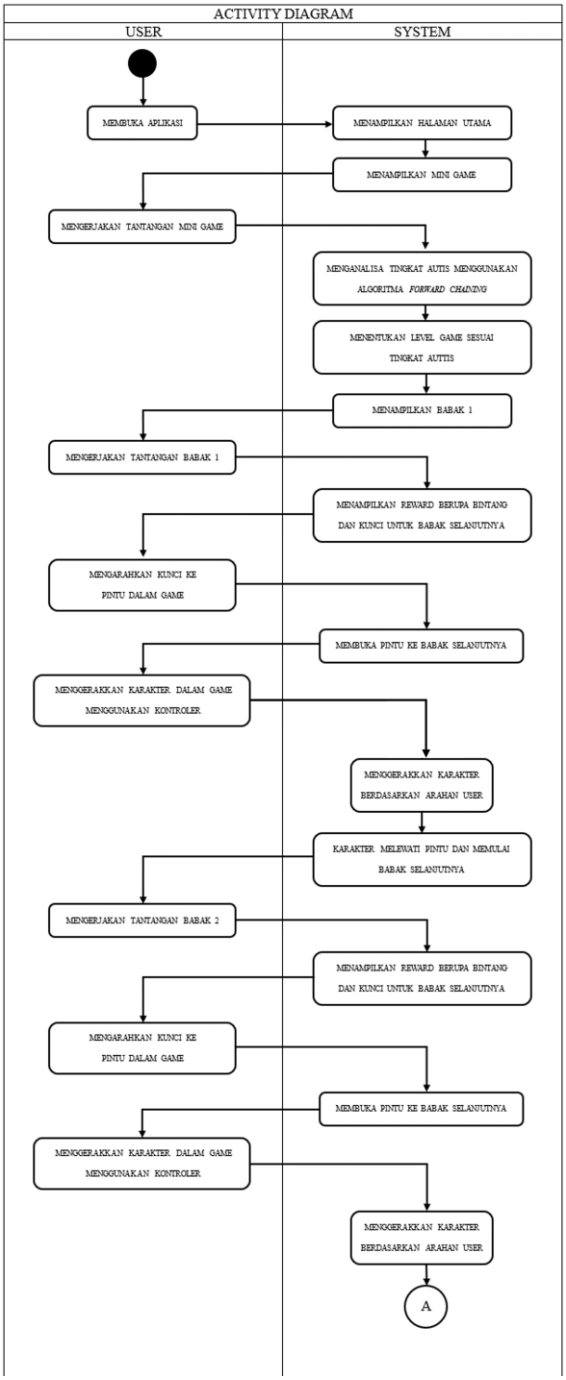


Figure 2. Flowchart

The mechanism and flow of users in operating educational games for autistic children can be seen in the following flowchart.

b. Activity Diagram

The activity diagram will provide an overview of the activities that will be carried out by the user in operating the application and how the application system can answer each user request and operation.



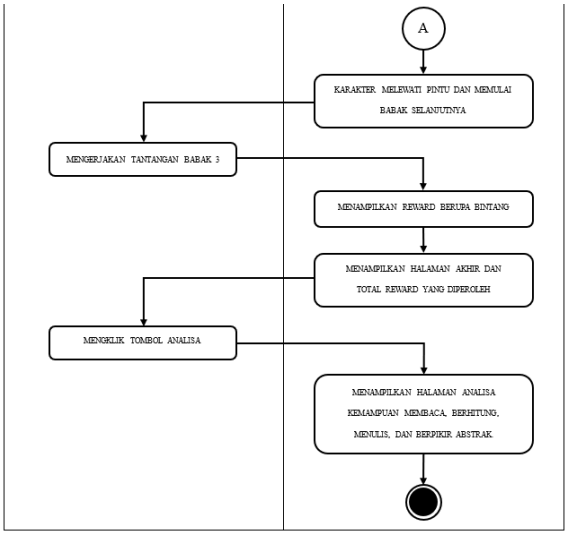


Figure 3. Activity Diagram

2. Interface Design

Designing educational games requires an interface design to provide an overview of the appearance and provide details about the elements used in the application.

a. Main Menu

The application's main page or home is the page that is first accessed and seen by users. This makes the main page a landing page that must have a competent display and navigation function.

Figure 4. Main Menu Interface Design

b. Mini Game

This page presents small challenges that children will complete before moving on to the main round.

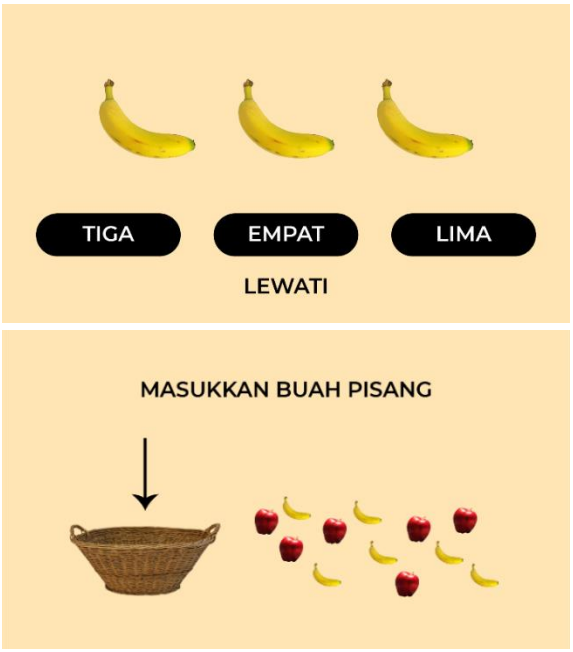


Figure 5. Mini Game Interface Design

c. Rounds 1 to 3

This page presents several challenges for children to complete to measure their reading, numeracy and abstract thinking skills.

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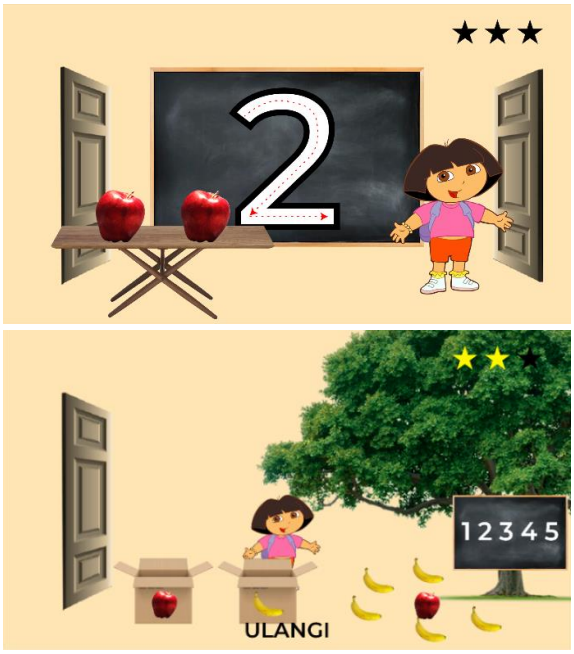

Figure 6. Main Game Interface Design

C. Data Analysis Technique

Data analysis techniques are methods for processing data into information that can be received by the subject. In this research, the author carried out data analysis techniques in the form of qualitative analysis using the Miles and Huberman model.

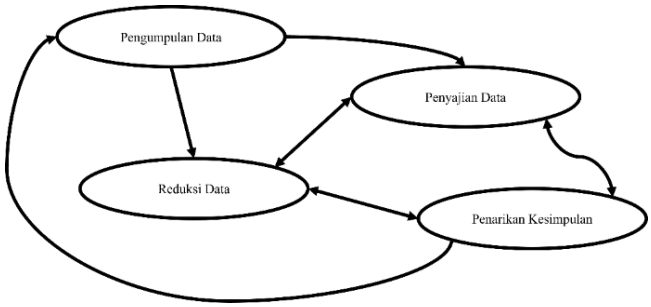

Figure 7. Miles and Huberman Model Data Analysis

1) Data collection, in the data collection process data analysis can also be carried out at the same time. The data is everything that is seen, heard and observed. The data obtained is not final data that can be directly analyzed to draw a final conclusion.
2) Data reduction, which takes place continuously as the research is carried out to further sharpen, classify, direct, discard unnecessary data and organize it.
3) Presentation of data, a collection of structured information that provides the possibility of drawing conclusions and taking action. By paying close attention to the presentation of the data, it is easier for researchers to understand what is happening and what needs to be done. The form of data presented can be in the form of a chart, brief description, graph, chart or table.
4) Drawing conclusions, researchers make conclusions that are supported by strong evidence at the data collection stage based on data that has been reduced and presented. Conclusions are answers to the formulation of problems and questions that have been expressed by researchers from the start.

III. Results and Discussion

This research produces an educational game application for students with autism with an expert system to determine the level of autism. This application was tested at a school that has an inclusion pathway, especially for students with autism. The name of this application is AutiSchool, because this game has a school theme. The objects used as objects in this educational game are apples, bananas and oranges, where these objects are objects that correspond to objects around us in everyday life. Fruits have a variety of bright and attractive colors, which can attract children's attention and arouse curiosity. Each fruit has a different shape, such as round, oval, or curved.

A. User Interface

The following are the results of the user interface design for educational games:

1. Application Icon

   This icon is also the logo for a game application for autistic children.

Figure 8. Game Icon

2. Main Menu Display

This page is the initial display when opening the application.

Figure 9. Homepage

There are four buttons on this page, namely "MULAI" to start the game, "INFO" and "VIDEO" to display information about autistic children in text and video form, and "KELUAR" to close the application.

Figure 10. Information about Autistic Child

Figure 11. Video about Autism

Figures 4.3 and 4.4 display information about the understanding and characteristics of autistic children in general.

3. Mini Game Display

This page displays mini games in the form of two types of tests that will be played before entering the main game.

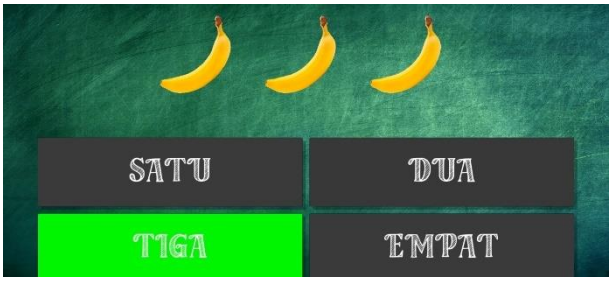

Figure 12. Mini Game 1 Display

Figure 13. Mini Game 2 Display

In Figure 4.2, the system will test autistic children in counting and reading one word. Apart from that, in Figure 4.3, the system will test autistic children's ability to read simple sentences and think abstractly. An expert system will process the test results, and summarize the results on the reward page based on its cognitive abilities.

4. Stage 1 Display

Figure 4.3 shows the challenges in stage 1 in the form of reading. This stage will provide instructions in the form of writing or sound and multiple choices in the form of fruit objects that must be clicked on the screen.

Figure 14. Stage 1 Display

When completing Stage 1, players will be asked to direct the character in the game and walk towards the next stage.

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Figure 15. Player Directs the Character Using a Controller

5. Stage 2 Display

Figure 4.4 is a challenge in stage 2 in the form of writing. The challenge given is 1 random number between numbers 1 to 5, which must be written on the screen.


Figure 16. Stage 2 Display

6. Stage 3 Display

Figure 4.5 is a challenge at stage 3 in the form of counting, reading and abstract thinking. The instructions given are in the form of audio and text in the form of story questions.

Figure 17. Stage 3 Display

7. Rewards Display

This page displays rewards when children successfully complete each stage of the game. The reward is in the form of stars, audio in the form of congratulations, and access to the next stage.

Figure 18. Reward Display

8. Final Page dan Analysis

This page is the final page of the entire series of games which displays the value of the ability to read, write, count and think abstractly from the three stages that have been played by students.

Figure 19. Analysis Page

This research uses black box testing, which is a method used to test an application without paying attention to the details. This testing only reviews inputs and outputs that are completely based on application specifications and requirements.

B. Blackbox Testing

This research uses black box testing, which is a method used to test an application without having to pay attention to the details. This testing only reviews inputs and outputs that are completely based on application specifications and requirements.

Table 1. Blackbox Results

No.	Description	Activity	Expected Results	Status
1	The game is accessible.	The game can be opened on a smartphone.	As expected.	Valid

2	The game displays the main page.	Displays the main page when opening the game.	Can display the main page when running.	Valid
3	Sound effect from every object in the game.	Sounds for every action in-game.	Can display sound effects.	Valid
4	Drag and drop feature.	Can pick up and move objects in-game.	User can pick up and move objects in-game.	Valid
5	Writing feature.	Makes player can write in-game.	User can use the in-game writing feature.	Valid
6	Answer options or choices	Options are clickable from each question.	User can click on in-game options.	Valid
7	Character movement	Character can be moved using the controller.	Players can make their characters walk using a controller.	Valid
8	In-game animation	The animation created can run in the game.	There are animations in the game.	Valid
9	Leveling	Concluding the level of ability based on game results using an expert system.	Conclusion of ability level can be performed.	Valid
10	Analysis of reading, writing, arithmetic and abstract thinking skills.	The system can analyze reading, writing, arithmetic and abstract thinking skills based on the games that have been played.	An explanation of student abilities is displayed on the analysis page.	Valid
11	Rewarding system	This game can give rewards when players complete each challenge.	Users receive rewards after playing.	Valid

C. Data Collection

This stage contains the results obtained during data collection, data processing, and other matters related to data collection that has been carried out in the field.

Table 2. Students Name Data

No.	Name	Class	Characteristic
1	H1	2	Flat facial expression, able to communicate but distracted.

2	A	1	Difficult to communicate with, minimal eye contact, often angry.
3	H2	3	Easy to talk to, can follow directions.

Table 4.2 is data on students, classes and levels of autism based on information from the relevant school teachers. For student A, based on the information obtained, this student has not been given assessment and therapy, so it cannot be concluded about her level of autism. Apart from that, he was also a transfer student, and that day was his first day of school.

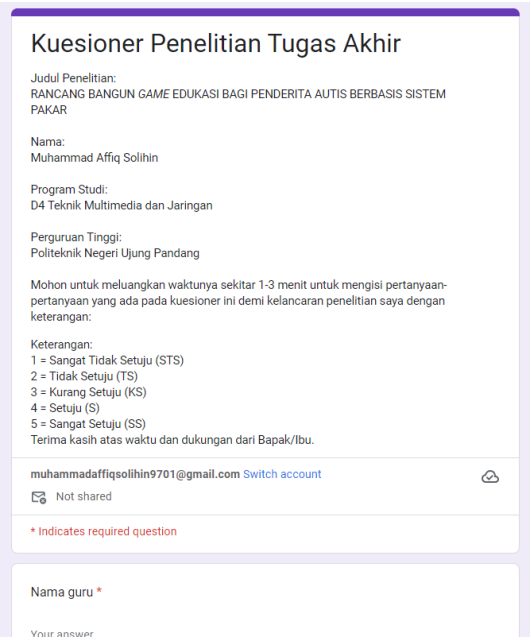
Table 3. Students' Reactions when Playing

No.	Name	Reaction
1	H1	His facial expression was flat, but he was able to focus on following the instructions given in the form of text or audio. The child is happy when he answers questions correctly. He also laughs when he hears the audio from the game, especially when he gets the answer wrong. When getting a reward, the child shows a normal expression. From a cognitive perspective, he can read a simple word or even a sentence. The child can follow the direction of the lines in the writing game. He wants to be invited to play again. For counting games, he can count additions up to 10.
2	A	At first, he was angry and raging, maybe because it was his first day at school. But when he was given a game, he calmed down and wanted to play it, even if he just pressed the buttons. He also sang along to the rhythm of the song. But the focus is often diverted to other things. He closed the app and opened another app.
3	H2	Easy to communicate with, can follow instructions without needing audio, happy when the answer is correct and gets a reward, and laughs when hearing the audio. From a cognitive perspective, you can answer, write, read and think, according to the instructions given.

Based on the data in table 4.3, audio can influence students' emotions, especially when they answer questions correctly and get rewards. This proves that rewards are one of the important elements in a game to make playing more enjoyable.

D. Data Collection Results

In this test, there were 7 respondents who filled out the questionnaire, consisting of 4 teachers accompanying children with special needs, 1 person who is an expert in psychology, 1 person who is an expert in IT, and 1 parent of the author.


Kuesioner Penelitian Tugas Akhir

Judul Penelitian:
RANCANG BANGUN *GAME* EDUKASI BAGI PENDERITA AUTIS BERBASIS SISTEM PAKAR

Nama:
Muhammad Affiq Solihin

Program Studi:
D4 Teknik Multimedia dan Jaringan

Perguruan Tinggi:
Politeknik Negeri Ujung Pandang

Mohon untuk meluangkan waktunya sekitar 1-3 menit untuk mengisi pertanyaan-pertanyaan yang ada pada kuesioner ini demi kelancaran penelitian saya dengan keterangan:

Keterangan:
1 = Sangat Tidak Setuju (STS)
2 = Tidak Setuju (TS)
3 = Kurang Setuju (KS)
4 = Setuju (S)
5 = Sangat Setuju (SS)
Terima kasih atas waktu dan dukungan dari Bapak/Ibu.

muhammadaffiqsolihin9701@gmail.com Switch account
Not shared
* Indicates required question

Nama guru *
Your answer

Figure 20. Research Questionnaire

Table 4. Questionnaire Results

No.	Question	Mark				
		1	2	3	4	5
1	Is the application accessible properly?	0	0	0	2	5
2	Can the features in this application work as they should?	0	0	0	3	4
3	Are the text type and size choices clear and appropriate?	0	0	0	3	4
4	Is the application easy to use and does not confuse students?	0	0	1	3	3
5	Can this application make it easier for students to learn and play?	0	0	0	2	5
6	Can the sound effects in this game help direct students in learning and playing?	0	0	0	1	6
7	Can the sound effects in this game affect students' emotions?	0	0	0	3	4
8	Can a rewarding system for students make them happy?	0	0	0	2	5

Table 4.4 displays the results of the questionnaire with 8 questions. The percentage diagram for questionnaire results is as follows.

$$Test\ Result = \frac{(0x1) + (0x2) + (1x3) + (19x4) + (36x5)}{(0 + 0 + 1 + 19 + 36)x5} x100\%$$

$$Test\ Result = \frac{259}{280} x100\% = 92{,}5\%$$

Based on the calculation results, a percentage of 92.5% was obtained, which based on assessment standards resulted in a very good score.

IV. Conclusion

Based on the results of research and analysis of educational game applications for autistic students using expert systems, it can be concluded that:

1. This educational game application was successfully created according to previously established plans, resulting in an application that works well and can be used as a learning and playing tool for autistic sufferers.
2. Based on the results of tests that have been carried out, there are various expressions of autistic children after playing this game, especially in the rewarding system when completing a level due to the audio and visual elements provided in the game.

There are several suggestions so that this system can be developed even better in the future, namely:

1. Added flow and procedures for playing in the game.
2. Provides more attractive images.
3. Create more varied types of games.

Acknowledgement

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