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Bijak Bicara: A Constructive Speech-Based Educational Game for Special Needs Students with Speech Delay

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ABSTRACT

Speech delay significantly impacts children's learning, social interactions, and cognitive development, affecting 10 to 20 percent of children in 2023. Traditional methods often neglect essential communication skills, prompting the need for innovative solutions. This project introduces a mobile game utilizing gamification and speech recognition technology to create an interactive learning environment. Designed following Ministry of Education guidelines, the game is a valuable tool for teachers and parents in Integrated Special Education Programs (ISEP). By addressing the lack of articulation exercises and limitations on learning tools, particularly in rural areas, this project aims to enhance communication skills and support children's speech development. In order to create a speech-based game mobile application that uses speech recognition technology to identify speech articulation, including common mispronunciations, the study uses an agile method approach that combines qualitative research on speech delay, with data analysis from participants with ISEP background. The effectiveness of the game was assessed through a post-test evaluation with 30 participants (14 teachers and 16 parents), leading to an overall effectiveness rating of 75.6%. Feedback indicates that 'Bijak Bicara' is beneficial for supporting students' articulation practice and provides a more engaging option compared to traditional methods. Future suggestions include adapting the game for different grade levels and exploring its use in various settings like ISEP schools in urban areas to further improve its effectiveness and reach.

1. Introduction

1.1 Research Background

Speech delay is a condition described when a child has trouble expressing themselves through language, which can affect their learning and development [1]. Communicating with words is essential for social and emotional health [2]. If a child has difficulty with speech, they may also struggle with cognitive skills like understanding and problem-solving [3]. Some children may struggle with articulation, making it hard to use language in everyday situations [4]. In 2023, about 10-20% of

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children faced speech issues, causing trouble in communication, and understanding language, impacting connections with others, and causing stress in school [5,6]. These problems, related to articulation difficulties due to structural or hearing problems, appear from insufficient practice in clear pronunciation and lack of proper learning tools [7]. Shinde *et al.,* [8] mentioned that parents often judge their children's speaking skills based on pronunciation, but effective communication involves more than just speaking clearly. This study also stated that effective communication involves gestures, emotions, and writing. Developing a good vocabulary is essential for communicating ideas [9]. Language difficulties can arise from a variety of causes, including cognitive impairments.

This educational mobile game project uses speech recognition technology that gives the player real-time feedback and guidance during gameplay. Empowering Integrated Special Education Program (ISEP) students at Sekolah Kebangsaan Bunohan, this project aims to help students with speech delay to get better at communication and cognitive abilities. The teachers in the ISEP also can use this game as an additional learning tool, and parents can use it as at-home therapy. This game is developed based on the guidelines provided by the Ministry of Education (MOE), focusing on basic 3M skills (‘membaca’, ‘menulis’, ‘mengira’). The content within the game aligns closely with the syllabus of the Standard 2 Malay Language textbook for students with learning difficulties. The game's content focuses on enhancing the pronunciation of syllables, words, phrases, and sentences. It also teaches basic vocabulary and sentence structure while evaluating students' ability to follow instructions and respond accurately.

1.2 Literature Review

Articulation problems are defined as problems that relate to the production of speech sounds. It is necessary to recognize the significance of speech impairments, particularly articulation disorders, for communication [4]. A study from [10] mentioned that children with working parents are more likely to have speech delays due to their parents’ lack of attention and guidance, which in turn influences their performance of articulation exercises [11]. In [8] have also mentioned that children are generally limited in the natural development of their speech. These limitations are caused by the lack of opportunities to exercise articulation, which is attributed to the parents’ schedule. However, it is necessary to give the younger generation another chance to enhance their speaking skills by practicing articulation. As a result, both formal and informal engagement and participation are required to improve their speech skills.

From the interviews that have been conducted, a teacher of Sekolah Kebangsaan Bunohan, Mr. Norazmin bin Mat Min, uses direct instruction and helps students with speech disorders to articulate through various exercises. However, these methods do not contain as many opportunities for the practice of articulation as one could expect. It shows that students may not get enough repetition and active engagement to improve speech clarity effectively. Mrs. Nurul Ajaratul Azmira binti Shokri, the ISEP supervisor at Sekolah Kebangsaan Bunohan, added that it may take three years for children, including those with autism spectrum disorder (ASD), to show development. The delayed communication development due to students’ progress is slow and gradual, which may hinder academic and social integration. The other problem is a lack of structured tools or guidance for parents to support articulation practice at home. Parents often struggle to understand their children when they speak, requiring the children to repeat themselves for better comprehension. The inconsistency in learning environments may reduce the effectiveness of speech improvement efforts.

In the articulation therapy technique, it follows a systematic approach with seven essential steps of sound stabilization and generalization. This technique involves monitoring the application of the target sound in various real-time situations and language contexts. If there are difficulties in

generalizing the correct pronunciation, additional practice in words, sentences, and stories may be necessary to ensure consistent and accurate production of the target sound in daily life. Figure 1 shows the steps of the articulation technique.

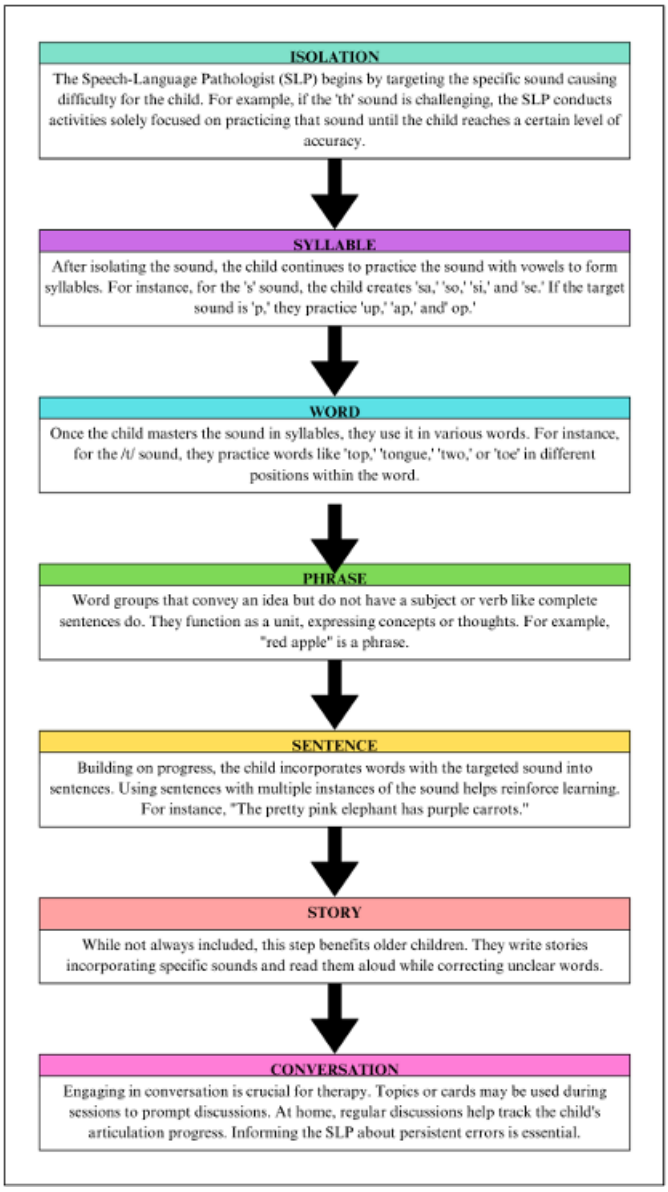


Fig. 1. Steps flow of articulation technique

The project only involves four articulation techniques, which are syllable, word, phrase, and sentence. The game incorporates text and images to support visual learners and reinforce articulation techniques. High-quality audio is integrated throughout the game to provide consistent and accurate pronunciation guides, enabling auditory reinforcement of speech sounds. Basic speech recognition is utilized to assess students' articulation attempts, offering immediate and adaptive feedback. The game employs a positive reinforcement system to celebrate progress and motivate continued practice.

Mobile games combining gamification and speech recognition technology can assist children with speech difficulties in learning and improving their language and communication skills [12]. As [13] pointed out, these games create user-friendly learning environments and allow for individual practice with real-time feedback. They emphasized that speech rehabilitation games differ from typical

children's games. These specialized games are tailored to therapeutic purposes, aiming to stimulate speech production. Despite the wide variety of speech games available, only a limited number specifically address imitation pronunciation. Research conducted by Ahmed *et al.,* [13] and Samonte *et al.,* [14] shows that mobile applications with speech recognition technology can provide precise assessments and solutions for a child's speech problems, leading to better therapy outcomes and faster progress in treatment. Unlike other games that use speech recognition, such as Sayin'it Sam, this game focuses on training [12]. It focuses on being patient and understanding to motivate kids who have trouble speaking to begin talking. SpokeIt was produced only as an articulation treatment assist, with the ability to listen critically to speech [12]. Table 1 shows the most similar applications in the realm of educational game projects that apply articulation approaches.

Table 1
Summarization of existing applications and developed application

Name / Features	Articulation Station	Articulation Arcade Lite	Otsimo	Bijak Bicara
Articulation Techniques	Word, Phrase, Sentence, Story	Word, Phrase, Sentence	Syllable, Word, Sentence	Syllable, Word, Phrase, Sentence
Technology	Voice Recognition	Speech Recognition	Voice Recognition	Speech Recognition
Platform	iOS	iOS	Android	Android
Language	English	English	English	Malay
Game Elements	Goal, Rule, Challenge, Story, Feedback, Level	Goal, Rule, Feedback, Level	Rule, Challenge, Interaction, Reward, Feedback,	Rule, Challenge, Reward, Feedback, Level

2. Methodology

The methodology used in this study is Agile, a systematic way of developing applications. Applying methodology enables software developers to improve their effectiveness and output, resulting in the delivery of product quality in a short time.

2.1 Requirement Phase

This phase involves important tasks like gathering information and data from past studies (journals, books, conference papers, newspaper reports) and conducting surveys and interviews with teachers from the Integrated Special Education Program at Sekolah Kebangsaan Bunohan and Sekolah Kebangsaan Sri Wakaf Bharu located in Kelantan, Malaysia. These activities are vital to gaining insights that will shape the project.

2.2 Design Phase

In the design phase, the project aligns with the identified requirements from the previous phase. This stage is crucial as it involves creating a detailed flowchart as a roadmap for the project's sequence and interactions. This step is essential for setting up the project's base and guiding the following development stages. Figure 2 shows the flowchart of Bijak Bicara application, in which every step of the flowchart corresponds to a specific articulation technique, such as syllables, words, phrases and sentences.

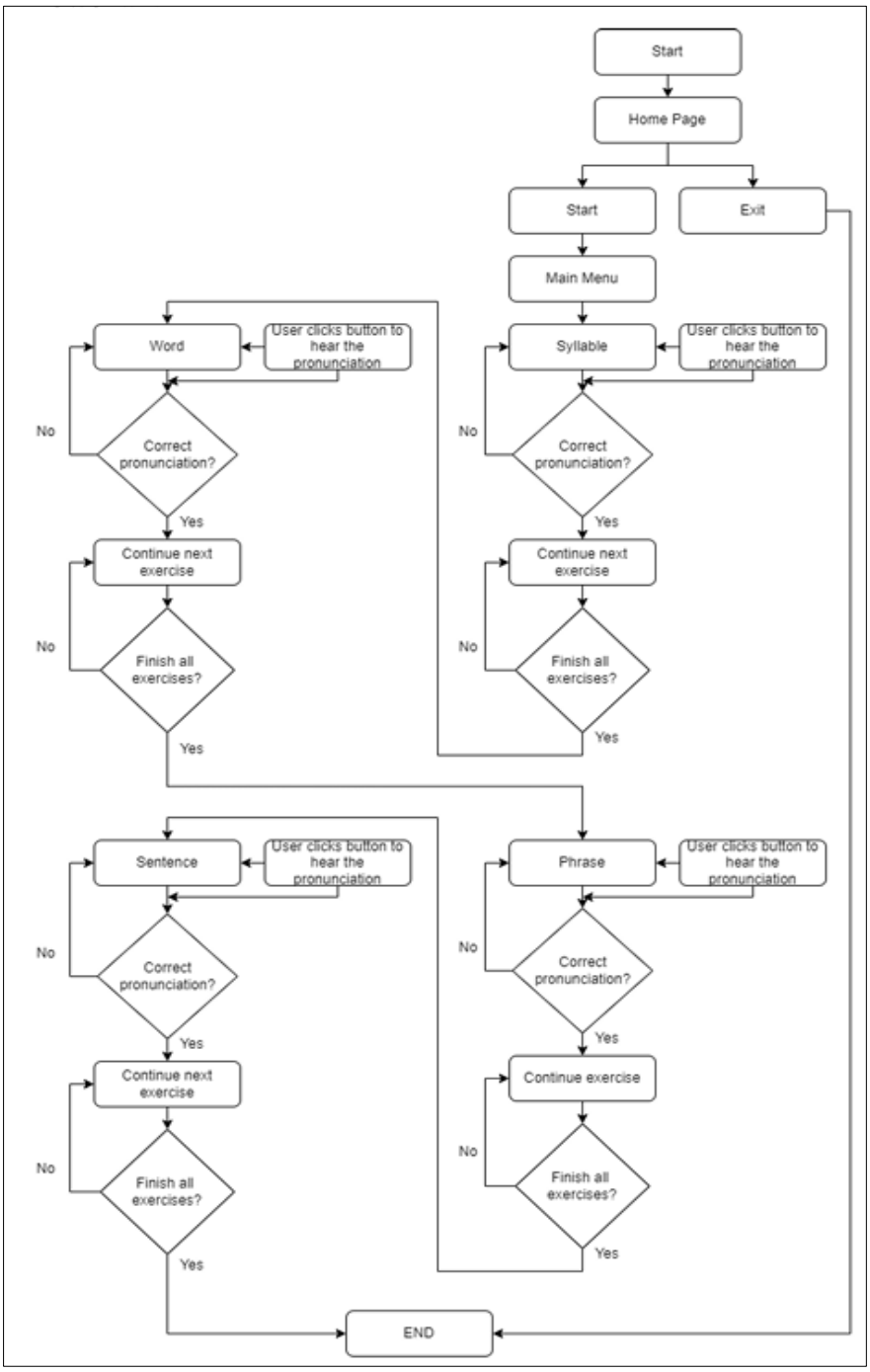


Fig. 2. Flowchart diagram of Bijak Bicara

2.3 Development Phase

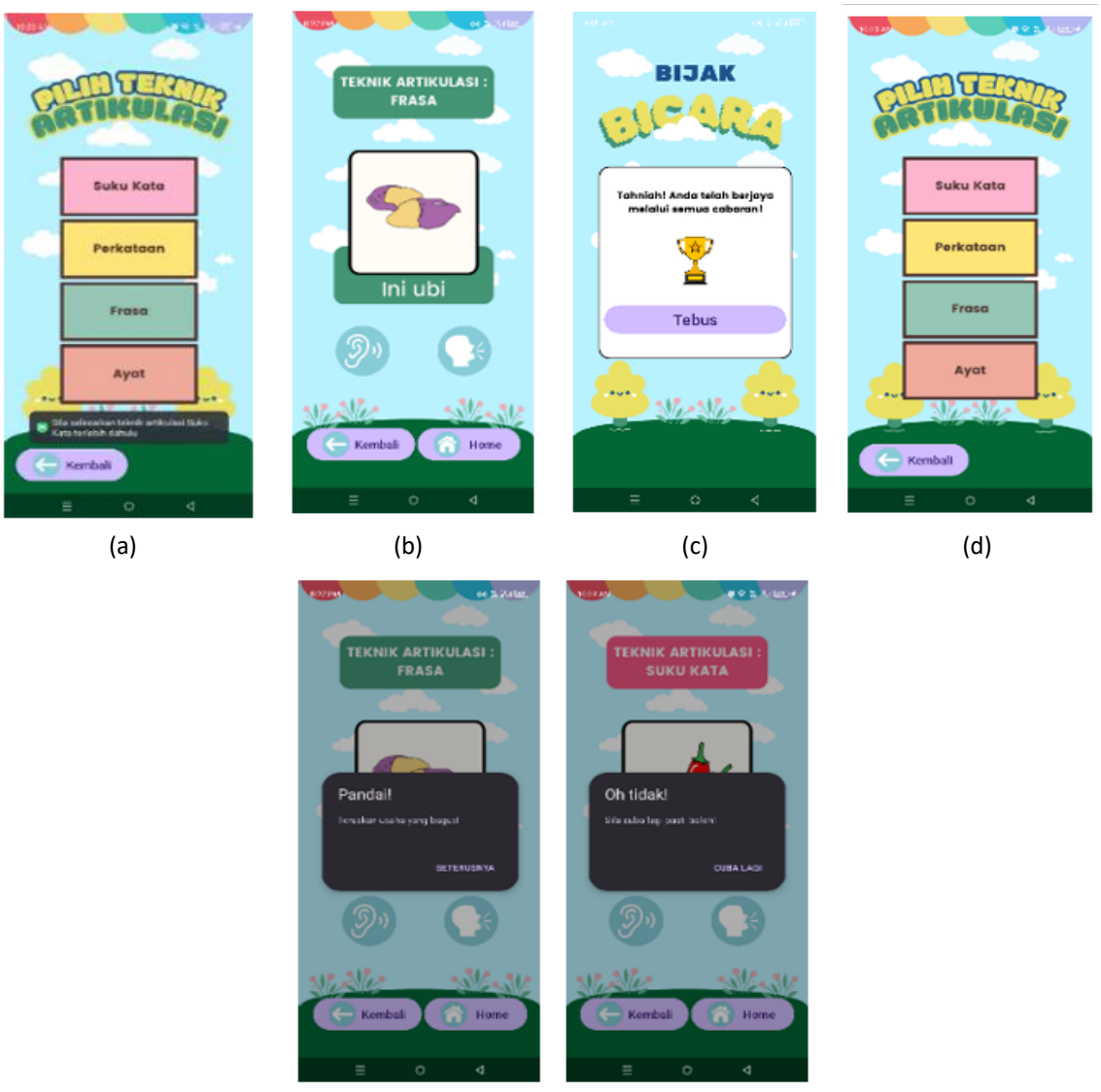
In line with the requirements and design outlined in the earlier phases, the Development Phase of the game is to provide support for students with speech delays through the implementation of speech recognition technology in the game. This stage involves the creation of an interface tailored to meet the specific needs of students, with a primary goal of ensuring accurate speech recognition to enhance articulation skills. To accomplish this, the project adopts Android's SpeechRecognizer API, integrating advanced speech recognition technology into the game development process.

In addition, the game's development employs Android Studio for creating the gameplay, ibisPaint X and Canva as 2D design tools, and the SpeechRecognizer API for integrating speech recognition,

with a focus on providing a user-friendly experience. The integration into mobile applications utilizes a native approach, combining speech recognition technology, game design, and mobile functionality. This method creates an effective educational tool and provides at-home practice for students with speech delays.

2.3.1 Game Elements Implementation

This project incorporates five game elements such as rules to guide user progression through the game, challenges to engage and motivate learning in different sections, rewards are to engage students through positive reinforcement, levels to provide a structured learning path based on articulation techniques, and feedback to monitor progress that helps players understand their performance. These elements are designed to create an enjoyable and effective game focused on speech practice, aiming to establish a supportive and engaging environment for students with speech delays. Figure 3 below shows the implementation of these five game elements in this project.



(a) (b) (c) (d)

(e)

Fig. 3. Game elements implementation (a) Rule (b) Challenge (c) Reward (d) Level (e) Feedback

2.3 Testing Phase

During the Testing Phase, the game is designed to assist students with speech delay using speech recognition, therefore, the game undergoes comprehensive examination. Teachers and parents will assess the game's impact on students and children's articulation skills by interacting with the game and observing its effect. They will observe how students engage with the game, noting any improvements in articulation techniques. Additionally, teachers and parents will collect feedback on the effectiveness of Bijak Bicara as a teaching tool for students with speech delay and as an at-home practice.

2.3.1 Participants

The participants consist of 14 teachers who teach the Malay Language to the Standard 2 students within the ISEP at a primary school and 16 parents that have Standard 2 speech delay children, enrolled in ISEP.

2.3.2 Instruments

Table 2 and Table 3 below show the questionnaire used in this project, based on a study by [15]. The items are split into two different measurements: articulation exercises and learning tool capability. It aims to evaluate how effective the game is as an additional teaching tool for teachers in schools and for supporting learning at home.

Table 2
Effectiveness questionnaire for articulation exercises

Measurement	Items	
Articulation Exercises	1	My student/child showed a positive response to using Bijak Bicara as an articulation practice tool. *Pelajar/anak saya menunjukkan respons positif terhadap penggunaan Bijak Bicara sebagai alat latihan artikulasi.*
	2	My student's/child's articulation skills improved with the use of Bijak Bicara. *Kemahiran artikulasi pelajar/anak saya meningkat dengan penggunaan Bijak Bicara*.
	3	My student/child prefers to use Bijak Bicara for articulation practice. *Pelajar/anak saya lebih suka menggunakan Bijak Bicara untuk latihan artikulasi.*
	4	Bijak Bicara is easier to use in the student's/child's learning environment. *Bijak Bicara lebih mudah digunakan dalam persekitaran pembelajaran pelajar/anak saya*.
	5	My student/child gives better responses during articulation practice using Bijak Bicara. *Pelajar/anak saya memberikan respons yang lebih baik semasa latihan artikulasi menggunakan Bijak Bicara*.

Table 3
Effectiveness questionnaire for learning tool capability measurement

Measurement	Items	
Learning Tool Capability	1	I will recommend the usage of Bijak Bicara to other teachers and parents of children with speech delays. *Saya akan mengesyorkan penggunaan Bijak Bicara kepada guru guru dan ibu bapa lain yang mempunyai anak dengan masalah pertuturan.*
	2	I find Bijak Bicara suitable and useful for teaching or suggesting to parents for home practice. *Saya mendapati Bijak Bicara sesuai dan berguna untuk pengajaran atau dicadangkan kepada ibu bapa untuk latihan di rumah.*
	3	Bijak Bicara is an effective tool for my student/child's articulation practice. *Bijak Bicara adalah alat yang berkesan untuk latihan artikulasi pelajar/anak saya*.
	4	I encountered difficulties using Bijak Bicara for my student/child's articulation practice. *Saya menghadapi kesukaran menggunakan Bijak Bicara untuk latihan artikulasi pelajar/anak saya*.
	5	Bijak Bicara can be easily used as a part of home-based learning. *Bijak Bicara mudah digunakan sebagai sebahagian daripada pembelajaran di rumah.*

2.3.3 Procedure

The parents and teachers in charge of the speech delay students were the ones who filled out the questionnaire and did the post-test. The responses were collected through Google Forms, and the participants could select from a Likert scale of 1 to 5 with the options strongly disagree, disagree, neutral, agree, and strongly agree. The teachers and parents should complete the questionnaire after the students and children have completed the game. In [16] noted that percentage analysis was used as the main approach in determining the level of effectiveness. This involved systematically organizing and categorizing the data to discern patterns and draw conclusions. In this way, the share of responses to each question was obtained, which allowed for the simplest analysis of the results. This process entailed checking the data, classification, tabulation, and computation of response frequencies and percentages. To gauge effectiveness, the formula used is:

$$Mean = \left(\frac{(P1\ x\ V1)+(P2\ x\ V2)+\cdots+(Pn\ x\ Vn)}{100}\right) \quad (1)$$

$$Percentage = \left(\frac{Total\ score\ obtained}{Maximum\ score}\right) \quad (2)$$

3. Results and Discussion

3.1 Effectiveness Results

The evaluation of this application aims to assess its effectiveness in assisting students with articulation exercises and its capabilities as an additional learning tool for teachers in schools and at-home practice. Scores are summed, averaged, and converted into percentages. An average score above 70% will indicate a positive outcome, reflecting the game's effectiveness in improving learning skills.

3.1.1 Articulation exercises

70% of participants agreed that their student or child showed a positive response to using 'Bijak Bicara' as an articulation practice tool, 10% strongly agreed, and followed by 20% were neutral. This indicates that most users believe 'Bijak Bicara' positively impacts their students' or children's articulation practice. Results also showed that 60% of participants agreed that their student's/child's articulation skills improved with the use of 'Bijak Bicara', 3.3% strongly agreed, followed by 33.3% were neutral. Only 3.3% of participants who disagreed with this. Therefore, it indicates that a significant majority of users believe 'Bijak Bicara' effectively enhances their students'/children's articulation skills.

Moreover, the result also indicates that 70% of participants agreed that they prefer to use 'Bijak Bicara' for articulation practice at school and home. Participants also found that this application is user-friendly within the learning environment of their students/children. In addition, 70% of participants agreed and the other 16.7% strongly agreed that their student/child gives better responses during articulation practice using 'Bijak Bicara' application.

3.1.2 Learning tool capability

The result shows that 60% of participants agreed and the other 16.7% strongly agreed that they would recommend the usage of 'Bijak Bicara' to other teachers and parents of children with speech delays. This indicates that a significant majority of users are willing to endorse 'Bijak Bicara' to their peers and other parents. Majority of the participants which more than 75% agreed that they find 'Bijak Bicara' suitable and useful for teaching, and perceive 'Bijak Bicara' as an effective tool in improving articulation skills for educational and home practice purposes.

Regarding the challenges in using this application, the result shows that 26.7% of participants disagreed and were neutral, followed by 20% who strongly disagreed, 16.7% who agreed, and 10% who strongly agreed about encountering difficulties using 'Bijak Bicara'. This indicates a varied response among users regarding the challenges faced while using the application. Lastly, the result also shows that 50% of participants agreed that 'Bijak Bicara' can be easily used as a part of home-based learning, followed by 33.3% who strongly agreed and 16.7% who were neutral. This indicates a strong positive perception among users regarding the ease of integrating 'Bijak Bicara' into home-based learning routines.

3.2 Discussion

Based on the previously discussed findings, each measure highlighted different aspects with varying mean values. An overall mean for each measure, reflecting general agreement on the effectiveness of 'Bijak Bicara' for articulation exercises and its capability as a learning tool, was calculated using the formula that is mentioned in section 2.3.3. Tables 4 and 5 provide an overview of the average mean results for 'Bijak Bicara's effectiveness in articulation exercises and its capability as a learning tool, respectively.

Table 4
Articulation exercises results

Items		N	Mean
1	My student/child showed a positive response to using 'Bijak Bicara' as an articulation practice tool.	30	3.90
2	My student/child's articulation skills improved with the use of 'Bijak Bicara'.	30	3.63
3	My student/child prefers to use 'Bijak Bicara' for articulation practice.	30	3.73
4	'Bijak Bicara' is easier to use in the student/child's learning environment.	30	3.8
5	My student/child gives better responses during articulation practice using 'Bijak Bicara'.	30	4.03
	TOTAL		3.82

Table 5
Learning tool capability results

Items		N	Mean
1	I will recommend the usage of 'Bijak Bicara' to other teachers and parents of children with speech delays.	30	3.93
2	I find 'Bijak Bicara' suitable and useful for teaching or suggesting to parents for home practice.	30	3.97
3	'Bijak Bicara' is an effective tool for my student/child's articulation practice.	30	3.87
4	I encountered difficulties using 'Bijak Bicara' for my student/child's articulation practice.	30	2.70
5	'Bijak Bicara' can be easily used as a part of home-based learning.	30	4.17
	TOTAL		3.73

Total overall mean and total overall percentages can be found in Table 6 below. It indicates a positive trend in the effectiveness of 'Bijak Bicara'. The highest mean, 3.82, reflects the effectiveness of articulation exercises. This suggests that the application significantly supports improvement in articulation skills. The second highest mean, 3.73, relates to the learning tool capability, demonstrating that the application is generally effective and user-friendly for educational purposes. The overall average agreeability rating is 3.73, indicating a positive response. This result was analyzed to ensure reliability, showing that a significant 75.6% of respondents believe that 'Bijak Bicara' can enhance articulation skills, and it is a valuable tool for practice. The findings suggest that using 'Bijak Bicara' is beneficial for both improving articulation and as a learning tool. Overall, the project's objectives have been met, which are developing an application that supports articulation exercises and assessing its effectiveness as a learning tool.

Table 6
Learning tool capability results

Measurements	Total Mean
Articulation Exercises	3.82
Learning Tool Capability	3.73
Total Overall Mean	3.78
Percentage of Overall Average (%)	75.6

4. Conclusions

The objectives of the project were satisfactorily accomplished. 'Bijak Bicara' has been created to assist students in the development of their speech abilities by providing support with articulation exercises. The application is equipped with speech recognition technology that analyses speech articulation and identifies common mispronunciations. According to user feedback, 'Bijak Bicara' has resulted in noteworthy enhancements in students' articulation abilities and is considered a valuable educational resource. In order to evaluate the effectiveness of 'Bijak Bicara' as a learning resource and as an articulation exercise instrument, an evaluation was conducted. The results indicate that this application has the potential to serve as a learning instrument and significantly support students' articulation practice.

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