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BIJAK BICARA: SPEECH-BASED 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 10-20% 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 serves as 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. 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 to further improve its effectiveness and reach.

Keywords: Speech delay; Gamification; Speech recognition; Integrated Special Education Programs (ISEP); Articulation exercises; Effectiveness evaluation

INTRODUCTION

Speech delay is a condition described when a child has trouble expressing themselves through language, which can affect their learning and development (Nugraha & Sinaga, 2023).

The ability to communicate with words is essential for social and emotional health (Hajesmaeel-Gohari et al., 2023). If a child has difficulty with speech, they may also struggle with cognitive skills like understanding and problem-solving (Zaki et al., 2017). Some children may have trouble with articulation, making it hard to use language in everyday situations (Heyselaar & Heijselaar, 2019).

In 2023, about 10-20% of children faced speech issues, causing trouble in communication, and understanding language, impacting connections with others, and causing stress in school (Sujaya et al., 2023; Widya & Juwita, 2023). These problems, related to articulation difficulties due to structural or hearing problems (Kim et al., 2023), appear from insufficient practice in clear pronunciation and lack of proper learning tools. Shinde et al. (2022) 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 (Jacob et al., 2023). Language difficulties can arise from a variety of causes, including cognitive impairments.

Mobile games combining gamification and speech recognition technology can assist children with speech difficulties in learning and improving their language and communication skills (Duval et al. 2018). As Ahmed et al. (2018) point out, these games create user-friendly learning environments and allow for individual practice with real-time feedback. The study by Liu et al. (2023) 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 Samonte et al. (2019) and Ahmed et al. (2018) show 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 (Duval et al., 2018). 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 (Duval et al., 2018).

This project uses (1) speech recognition technology that gives the player (2) real-time feedback and (3) guidance during gameplay. This project aims to help students with speech

delay to get better at communication and cognitive abilities. The teachers in the Integrated Special Education Program (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 fundamental skills in reading, writing, and arithmetic, commonly referred to as the basic 3M skills. The content within the game aligns closely with the syllabus of the Standard 2 Malay Language textbook for students with learning difficulties.

LITERATURE REVIEW

Children with Speech Delay in Malaysia

In Malaysia, the Persons with Disabilities Act 2008 ensures that children with learning difficulties have the right to education (Othman et al., 2022). The Department of Social Welfare recognizes speech delays as a form of learning disability and offers various support services. The Special Education Service Centre provides crucial interventions, rehabilitation, and consultations, including speech-language therapy, to aid students with special needs. Additionally, school-based speech therapy sessions and the Outreach Program help children develop their communication skills and receive early intervention.

Around 10% of 400,000 children in Malaysia have speech delays, with boys being three times more likely to be affected (Kosmo!, 2022). Early identification of these delays is essential, and collaborative efforts among education departments and various agencies provide the necessary support and raise community awareness. The government's commitment to offering equal educational opportunities is vital for addressing and bridging developmental gaps in language and communication skills.

Integrated Special Education Program (ISEP)

According to the Special Education Data Book from October 31, 2022, 919 students with speech delays were enrolled in the ISEP across all educational levels in Malaysia, including 414 in primary school. The 2019 UNICEF study revealed that over half of children with disabilities in Sabah were not attending school, highlighting a significant dropout issue. To address this, MOE implemented the ISEP to provide special needs students (SNS) access to

relevant education. SNS are identified by medical professionals for various impairments, including vision, hearing, and speech.

ISEP aims to develop the abilities and potential of SNS through vocational education and early intervention programs, ensuring they receive appropriate educational opportunities tailored to their needs. The program strives to integrate SNS into regular classrooms whenever possible, fostering inclusive education. A trial period of up to three months is mandated for new students, during which their progress is closely monitored by teachers and administrators to ensure successful integration.

The proposed project, a speech-based game for children with speech delays, aligns with ISEP's objectives. By using speech recognition technology, the game aims to improve pronunciation skills, serving as an additional tool to support the education and development of students with disabilities. This initiative enhances ISEP's mission to provide comprehensive educational opportunities for SNS.

Raising Problems Regarding Speech Delay

Children with speech delays often face challenges in learning, social interactions, cognitive development, and overall well-being. They may struggle to interact with peers and follow instructions, leading to stress and academic difficulties (Nugraha & Sinaga, 2023; Hajesmaeel-Gohari et al., 2023; Widya & Juwita, 2023). These delays can also make it harder for them to understand complex ideas and solve problems (Zaki et al., 2017).

Parental acceptance of a child's speech delay is crucial yet sometimes difficult. Mrs. Norhidayati shared that some parents find it hard to seek specialist help or have different views on their child's needs, which can delay their child's enrollment in the ISEP and timely intervention. Additionally, concerns about social stigma might lead some parents to hesitate in applying for a Person with Disabilities (PWD) card, even though it could be beneficial. This situation underscores the emotional challenges parents face when seeking professional help for their children.

Lack of Articulation Exercises

Children of working parents often experience speech delays due to a lack of attention and guidance, which limits their opportunities for practicing articulation exercises (Fitriyani et al., 2019; Okitasari et al., 2023). Factors such as birth order and age also influence the amount of

attention younger children receive, further hindering speech development (Shinde et al., 2022). At Sekolah Kebangsaan Bunohan, Mr. Norazmin bin Mat Min uses direct instruction to support students with speech disorders, but these methods offer limited practice opportunities. Mrs. Nurul Ajaratul Azmira binti Shokri indicated that it may take up to three years for significant progress, particularly for children with autism spectrum disorder (ASD). Sundari and Mariani (2022) also highlighted the challenges both teachers and parents face in understanding children's speech, necessitating repeated practice for better comprehension.

Limitation on Learning Tools Capabilities

Kumar et al. (2022) and Hestiyana et al. (2021) highlight that limited learning resources contribute to speech disorders in children, particularly those from low-income families. This inadequacy affects speech development and early intervention, while also increasing stress and feelings of inadequacy among these children. Hair et al. (2021) emphasize that financial barriers hinder access to regular speech therapy and essential learning materials, resulting in inconsistent treatment.

At Sekolah Kebangsaan Bunohan, Mr. Norazmin bin Mat Min mentioned that the school mainly uses laptops to display videos and conduct singing sessions but does not utilize online or mobile educational games due to limited exposure. Bao et al. (2017) and Mallillin (2021) found that the lack of language-specific tools, especially in Bahasa Malaysia, restricts effective teaching. Samarasinghe and Abeyasinghe (2021) also noted that many educational apps are available only in English, making them less accessible for non-English-speaking students.

Articulation Techniques

According to Furlong et al. (2021) and Bennett (2022), Van Riper's articulation therapy technique systematically addresses articulation disorders through seven essential steps: isolation, syllable practice, word practice, phrase formation, sentence construction, storytelling, and conversation. For instance, a child struggling with the 's' sound first practices the sound alone, then in syllables like 'sa,' followed by using it in words such as 'top,' phrases like "red apple," and sentences like "The pretty pink elephant has purple carrots." The goal is to generalize the correct sound production across various real-life contexts. Tools like

electropalatography (EPG) and nasopharyngoscopy assist in correcting articulatory errors and enhancing therapy effectiveness.

Integrating these systematic steps into a speech-based game can make articulation practice more engaging for children with speech delays. This project will focus on syllable, word, phrase, and sentence-based techniques, as conversation and storytelling might be too advanced for their current level. By using these techniques, the game aims to improve articulation skills in a fun and interactive way. Teachers typically introduce isolation techniques during preschool and Standard 1, laying the foundation for more complex speech elements.

Speech Recognition

Speech recognition technology, including Automatic Speech Recognition (ASR), allows users to control devices with their voice and supports language learning by converting spoken words into text (Pahwa et al., 2020; Kumar & Mittal, 2019). Although ASR has faced challenges in recognizing non-native and child speech, recent advancements suggest it can effectively support language learning for a broad range of users, including those with less developed languages (Wills et al., 2023; Karimi & Nickpayam, 2017). Mobile applications for speech therapy benefit from ASR by offering immediate feedback on pronunciation, which is particularly useful for children with speech delays. This technology enables self-paced practice and provides flexible, consistent opportunities for speech improvement beyond traditional settings (Duval et al., 2018; Bhardwaj et al., 2022).

Gamification in Learning

Technology increasingly influences education by enhancing traditional methods and promoting active, personalized learning (Ridhon & Daulay, 2023). Gamification, a promising technology, supports this transformation by incorporating game elements into educational practices, making learning more engaging and effective (Yan, 2023; Yıldırım, 2023). It helps connect teachers and students and is used across different educational levels to boost involvement and understanding (Gounaridou et al., 2021; Vrcelj et al., 2023). For students with speech delays, gamification offers a fun and motivating way to practice speech exercises. The project aims to use game features like rules, challenges, and feedback to make speech practice

enjoyable and effective, supporting adaptive learning and providing immediate feedback to help students improve their speech skills.

Game Elements

Table 1 summarizes key game elements identified by Yunus and Zaibon (2021), Lomos et al. (2023), Boden et al. (2023), and Cui and Yang (2023). It details essential components like goals, rules, challenges, stories, interaction, collaboration, rewards, feedback, timers, and character personalization, which are vital for creating an engaging and effective gaming experience.

Table 1: Game Elements

Game Elements	Roles	Example
Goal	Defines the objective or target of the game, distinguishing it from a toy.	Ultimate achievement that determines winning the game.
Rules	Guidelines that set boundaries and determine how the game operates, impacting its quality.	Guidelines on what players can and cannot do.
Challenges	Obstacles that increase difficulty as players progress, based on their knowledge and skills.	Varying levels of difficulty based on player progress.
Story	Provides context and background, enhancing player engagement and immersion.	Narrative that helps players understand their role.
Interaction	Encourages engagement with the game environment or among players.	Interactive elements that promote player involvement.
Collaboration	Fosters team-based activities and collaborative learning.	Group tasks and cooperative gameplay.
Reward	Offers positive reinforcement through points or badges to motivate players.	Points, badges, or other incentives for progress.
Feedback	Provides information on player actions, assessing progress and guiding improvement.	Feedback on performance given at the end of game sessions.
Timer	Creates urgency by tracking game time, influencing performance and progress assessment.	Timers that show real-time performance and progress.
Character and Personalization	Enhances gaming experience through customizable avatars and items.	Avatars with unlockable items and customization options.
Level	Adapts the game's difficulty and environment as players advance, connecting rewards and milestones.	Progressive levels that introduce new challenges.

Based on the elements discussed for the game, this project includes key features like rules to guide gameplay, challenges to engage and stimulate learning, feedback for tracking progress, and levels to offer a step-by-step learning experience. These elements aim to create

an enjoyable and effective speech-based game for students with speech delays, establishing a supportive and engaging learning environment.

Game Genre

Exploring different studies by Gui et al. (2023), Hassan et al. (2019), Kumar and Singla (2022), Wibowo and Novianto (2022), and Hertati (2022) reveals a wide range of game genres.

Table 2: Game Genre

Game Genre	Description	Example
Role-Playing Games (RPGs)	Provide immersive narratives with player decisions affecting game progression.	World of Warcraft
Strategy Games	Focus on strategic planning and skillful execution, minimizing luck.	Clash of Clans
Simulation Games	Recreate real-life scenarios for skill practice in a virtual setting.	The Sims 4
Adventure Games	Combine exploration and puzzle-solving, requiring logical and pattern-based thinking.	Jigsaw Puzzle
Action Games	Offer challenges involving shooting, fighting, and physical skills like reaction times and coordination.	Battleship
Sports Games	Simulate real-life sports, requiring physical skills and adhering to sports rules.	NBA Jam
Racing Games	Emphasize competition and speed, pushing players to outperform opponents.	Forza Horizon 3
Educational Games	Make learning engaging and can improve academic performance.	Veggie Friends

Research by Gui et al. (2023), Hassan et al. (2019), Kumar and Singla (2022), Wibowo and Novianto (2022), and Hertati (2022) shows that diverse game genres cater to different interests, offering experiences from engaging narratives to strategic challenges and adventures. The proposed project focuses on the educational game genre due to its benefits, such as making learning enjoyable, improving comprehension, and enhancing academic performance.

METHODOLOGY

Agile Software Development has gained popularity for its efficiency in delivering customer value and enhancing task management, leading to improved effectiveness and completion rates (Kim et al., 2021; Traini, 2022; Nyembe et al., 2023). The Agile process, which includes planning, requirements gathering, design, development, testing, deployment, and review (Al-Saqqa et al., 2020), is flexible and allows for easy adjustments, enabling developers to produce quality products quickly. Agile's benefits include developmental

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flexibility, adaptability to change, a customer-centric approach, continuous learning, and quick responsiveness (Chahal, 2023; Alshurideh et al., 2023; Locatelli et al., 2023).

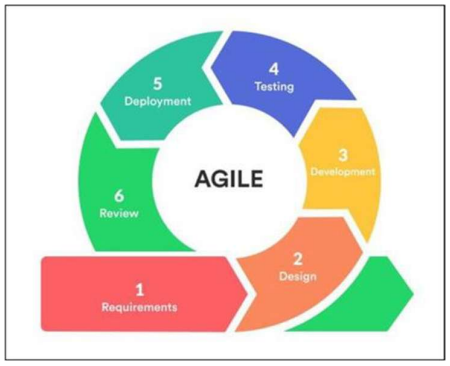

Figure 1: Agile Model

For the project that develops a game to assist students with speech delays, Agile's iterative improvements and short development cycles offer significant benefits. The project begins with gathering data and defining the scope in the Requirement Phase, then moves to the Design Phase, where a flowchart and storyboard are created. During the Development Phase, the project integrates Android's SpeechRecognizer API and design tools to build the game. The Testing Phase includes collecting feedback from teachers and parents. Although the Deployment and Review Phases are not executed at the prototype level, they typically ensure functionality and adherence to requirements.

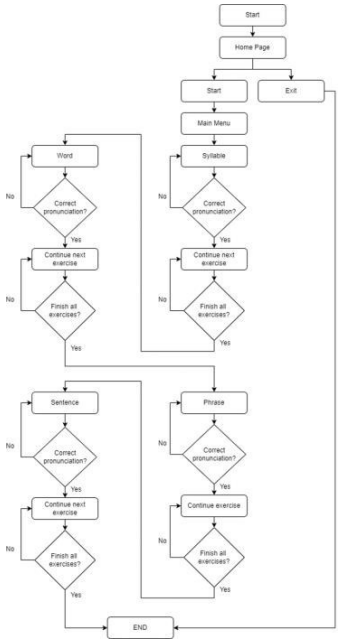

Figure 2: Flowchart of Bijak Bicara

User Testing

14 ISEP teachers and 16 parents of Standard 2 children with speech delays participated in the study, completing a questionnaire based on Kamaruddin et al. (2023) to evaluate the game's effectiveness as a teaching tool and home learning support. The responses were collected via Google Forms using a Likert scale from 1 to 5 and analyzed with percentage analysis, as described by Samboteng et al. (2023), to identify patterns and draw conclusions. The formula used was: Percentage = (total score obtained / maximum score) x 100%.

RESULT AND DISCUSSION

An overall mean for each measure, reflecting general agreement on the effectiveness of Bijak Bicara for articulation exercises and its role as a learning tool, was calculated. The questionnaires assessing these elements were analyzed to determine the average results. Tables 3 and 4 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 3: Articulation Exercises Results

Articulation Exercises Measurements		**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's/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's/child's learning environment.	30	3.80
5.	My student/child gives better responses during articulation practice using Bijak Bicara.	30	4.03
		TOTAL	**3.82**

For the articulation exercises measurement, the overall mean is 3.82. The highest mean among the items was 4.03, and the lowest mean was 3.63.

Table 4: Learning Tool Capability Results

Learning Tool Capability Measurements		**N**	**Mean**
1.	I will recommend the usage of Bijak Bicara to other teachers and parents of child 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's/child's articulation practice.	30	3.87
4.	I encountered difficulties using Bijak Bicara for my student's/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**

For the learning tool capability measurement, the overall mean is 3.73. The highest mean among the items was 4.17, while the lowest mean was 2.70. Total overall mean and total overall percentages can be found in Table 5 below.

Table 5: Total Average for Each Measurement and Overall Average Value

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

The data analysis indicates that respondents generally support using Bijak Bicara for articulation exercises. Specifically, the mean rating for articulation exercises is 3.82, and for learning tool capability, it is 3.73. About 75.6% of respondents feel that Bijak Bicara effectively improves students' articulation skills and serves as a helpful educational tool. These findings suggest that Bijak Bicara is a valuable addition to articulation practice in educational settings.

CONCLUSION

To conclude, Bijak Bicara has achieved its goals of assisting students with articulation exercises and improving their speech skills. The application, which integrates speech recognition technology and gamification features, has been positively received, suggesting it effectively supports articulation practice and enhances the learning experience. While the initial evaluation indicates good performance, exploring the application in various settings and for different age groups could offer additional insights into its broader effectiveness and usefulness.

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