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MyIsyARat: Bridging Communication Gaps through Bahasa Isyarat Malaysia (BIM) with Augmented Reality (AR)

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Abstract

Bahasa Isyarat Malaysia (BIM) is the primary visual language of the Malaysian deaf community, yet it remains underrepresented in mainstream education and digital platforms. To address this gap, MyIsyARat was developed, i.e., an augmented reality (AR)-based mobile application designed to support interactive and engaging BIM learning. Using the Multimedia Development Life Cycle (MDLC) model, the app features 3D animated signs across three key themes: *Kata Ganti Nama* (Pronouns), *Ucapan* (Greetings), and *Keluarga* (Family). User testing involving diverse participants showed strong positive feedback, with average mean scores of 4.23 for App Usability, 4.18 for Content Quality, and 4.31 for Engagement and Learning Experience. These results indicate high levels of user satisfaction and acceptance. More than just a learning tool, MyIsyARat fosters inclusivity, promotes empathy, and supports communication between Deaf and hearing communities, moving one step closer to language equity in Malaysia.

1. Introduction

Imagine being unable to communicate your thoughts, emotions, or needs with those around you. It is not because you have nothing to say but because the world has not learned your language. This scenario is the everyday reality for many members of Malaysia's Deaf community, for whom *Bahasa Isyarat Malaysia* (BIM) is not just a language but a lifeline. Although BIM has been officially recognized as the natural language of the Malaysian Deaf community, access to engaging and effective learning tools remains limited. As of 2023, the Department of Welfare Malaysia recorded over 46,000 individuals with hearing disabilities, with Malays forming the majority [1]. Despite these numbers, the societal understanding of BIM and, more critically, its integration into education and daily communication, continues to lag. Existing resources are often outdated, passive, or designed around *Kod Tangan Bahasa Malaysia* (KTBM), which lacks the full expressive power of BIM [2]. This disconnect has contributed to a lack of interest in learning, especially among younger users.

The situation is even more pressing for the 96% of deaf children born to hearing parents, who often lack proficiency in sign language. This communication gap can lead to missed emotional connections, academic struggles, and delayed cognitive development. Research warns of language deprivation, a condition that arises

when children are not exposed to accessible language during their formative years [3]. In this digital age, technology offers a new avenue of hope. Augmented Reality (AR), with its ability to create immersive and interactive experiences has shown tremendous promise in educational settings. AR tools have been proven to enhance memory retention, increase motivation, and support visual learning styles [4].

Recognizing how many deaf individuals still struggle to access meaningful and interactive tools for learning their language, MyIsyARat was born to change that reality. By combining the power of AR with the richness of BIM, this app offers a more immersive, engaging, and inclusive learning experience that aims to make communication more accessible and connections more human.

1.1 Problem Statement

Many deaf individuals still lack access to learning tools that are not only engaging and accessible but also culturally aligned with their lived experiences. This gap is especially evident in the BIM learning, where resources are limited and often fail to cater to the deaf community and their hearing family members. A common source of confusion arises from the frequent misinterpretation of BIM with KTBM, despite the two serving different linguistic roles [2]. BIM as a natural language of the deaf community and KTBM as a manually coded version of spoken Malay. This confusion, coupled with the fact that many hearing parents of deaf children possess only basic sign language knowledge, makes daily communication a struggle [5]. As a result, deaf children are often left out of meaningful family interactions, a phenomenon widely known as “Dinner Table Syndrome”, a term that captures the emotional reality of being physically present but socially invisible [6]. Such exclusion can long-term impact emotional well-being, self-esteem, and cognitive development.

There is an urgent need for an inclusive educational solution that goes beyond formal instruction to support the natural, everyday use of BIM. By incorporating interactive technologies like AR, such a tool could make learning more intuitive and enjoyable while helping bridge the communication gap that isolates so many in the deaf community.

1.2 Objective and Scope

This study focuses on developing MyIsyARat, an AR-based mobile application that enhances the learning and use of BIM more engagingly and inclusively. The main objectives are threefold: first, to identify and validate essential BIM content and user-preferred features through interviews with experts and insights gathered from potential users; second, to design and develop a mobile application that integrates 3D visualizations and interactive elements using AR to enrich the learning process; and third, to assess the application’s usability, engagement level, and educational effectiveness through user testing and feedback.

The scope of MyIsyARat centers around three fundamental BIM categories, i.e., *Kata Ganti Nama* (pronouns), *Ucapan* (greetings), and *Keluarga* (family-related terms), which were chosen for their relevance to daily, informal communication. Designed to benefit not only deaf users but also hearing family members, educators, and the public, MyIsyARat aims to create a shared communication space that nurtures understanding, empathy, and inclusion through the natural use of sign language.

1.3 Related Works

Communication is a fundamental human need, yet for the deaf community, the lack of accessible communication tools often leads to social exclusion, educational disadvantages, and emotional isolation. In Malaysia, BIM is officially recognized as the natural language of the deaf community. Despite this recognition, resources that support the learning and use of BIM remain limited. Moreover, the technological integration of BIM into educational tools has not kept pace with advancements in immersive media such as AR, which has shown potential to enhance learner engagement, comprehension, and retention. This literature review explores existing studies on sign language education, the role of AR in inclusive education, and recent technological efforts aimed at bridging communication gaps within the deaf community. Through this review, the study highlights the gaps and opportunities that MyIsyARat aims to address.

1.3.1 Sign Language Learning Tools and Challenges

Sign language plays a crucial role in the cognitive, linguistic, and social development of deaf individuals. However, the process of acquiring sign language especially for hearing individuals such as parents, teachers, and peers is often hindered by a lack of structured, accessible, and motivating learning tools. Research has shown that many existing sign language resources are static, text-heavy, or limited to video-based demonstrations that fail to encourage active learning and two-way interaction [7]. Moreover, these tools often lack personalization, real-time feedback, or the ability to simulate real-life conversations.

Compounding this challenge is the reality that most deaf children are born to parents who typically do not possess sign language skills [8]. This communication gap can lead to emotional disconnects, reduced language

exposure during critical developmental years, and a phenomenon commonly called “language deprivation” [9]. The absence of engaging and accessible learning tools thus contributes not only to slow adoption of sign language but also to lifelong barriers in communication, education, and social participation for the deaf. Consequently, a growing call is for more innovative, inclusive, and culturally relevant tools to support sign language acquisition. Effective solutions must not only address the linguistic needs of deaf users but also empower their hearing counterparts to become active participants in inclusive communication.

1.3.2 The Role of Technology in Inclusive Education

Technology has become more than just a classroom aid in today's digital age. It is a bridge toward equal learning opportunities for all, especially for students with disabilities. Inclusive education goes beyond ensuring school presence; it is about active participation, understanding, and connection. For deaf and hard-of-hearing individuals, communication barriers often hinder this connection, but technology is helping close that gap [10]. Innovative tools like speech-to-text software, captioned videos, and interactive learning apps increasingly support diverse learning needs. AR has emerged as a promising approach. Unlike traditional media, AR can bring abstract or complex concepts to life by layering digital information over the real world. This technology creates a more immersive and visually rich experience, something especially valuable for visual learners, including many in the deaf community [11]. Studies show that AR helps students better engage with content, stay motivated, and retain what they learn longer. When used intentionally, such technology supports Universal Design for Learning (UDL) principles by catering to various learning preferences, whether visual, kinesthetic, or auditory [12].

1.3.3 Existing Apps or Educational Tools for Sign Language

In recent years, there has been growing interest in developing digital tools to support inclusive education, especially for the Deaf and hard-of-hearing communities. Several applications have emerged, aiming to teach sign languages or enhance communication through visual and interactive means. However, many of these tools are not tailored to Malaysian users' unique cultural and linguistic context, particularly those who use BIM. The development of MyIsyARat builds upon existing research and applications in sign language learning and AR. Prior to development, a comparative study was conducted on several relevant applications. Table 1 explores the current educational tools for teaching sign language to deaf students, examining the limitations of existing materials and the potential benefits of specialized learning aids.

Table 1 *Comparison of Strengths and Weaknesses Among Existing Applications*

Application	Strengths	Weaknesses
KTBM AR [13]	• It uses 3D animated models triggered by flashcards. • Includes structured learning modules and activities. • Available on the Google Play Store for Android devices.	• It focuses on KTBM, not BIM. • There is no support for free-form interaction, voice, or text inputs. • Lacks cultural or informal language usage.
KoTBaM [14]	• Features real human interpreters. • Simple interface suitable for early learners. • Available exclusively on the Google Play Store for Android devices.	• It focuses on KTBM, not BIM. • Limited interactivity and customization. • No AR integration. • Lacks gamified or immersive learning experiences.
StorySign [15]	• It uses expressive animated avatars. • Integrates printed books for literacy support. • Supports multiple European sign languages. • Available on both the Google Play Store and Huawei AppGallery.	• It requires specific printed storybooks. • It does not support Malaysian sign systems or culture. • Not customizable for BIM use cases.

Table 1 *(cont.)*

Application	Strengths	Weaknesses
Hand Talk Translator [16]	• Supports real-time voice and text translation. • It uses an animated avatar with fluid signing. • Multiple input modes enhance accessibility. • Available on both Android and iOS platforms.	• Limited to Brazilian Sign Language (Libras). • Not suitable for structured language learning. • No support for Malaysian context or BIM.
Bimo AR [17]	• Highly interactive AR experience. • Designed for preschool engagement with animation and sound. • Available exclusively on the Apple App Store for iOS devices.	• General-purpose app, not focused on sign language. • No linguistic or communication features. • Lacks cultural and educational depth for Deaf users.
Mari Belajar PAI [18]	• It uses 3D models triggered by flashcards. • Support for Year 1 Pendidikan Agama Islam. • Available on the Google Play Store for Android devices.	• It focuses on KTBM, not BIM. • Designed only for primary school
ARithmetic [19]	• It uses 3D models triggered by flashcards. • Support for Year 1 Mathematics. • Available on the Google Play Store.	• It focuses on KTBM, not BIM. • Designed only for primary school.

Based on Table 1, most apps focus on KTBM or international sign systems. The lack of applications centered on BIM, especially using AR, highlights a significant gap. BIM, unlike KTBM, is a naturally developed language used by the deaf community in everyday settings. While KTBM aligns with Malay syntax and serves academic purposes, it is less intuitive and fluid in daily conversation, making it unsuitable for broader communication needs. The reviewed applications offer limited relevance for Malaysian users seeking to learn BIM. For instance, KTBM AR, KoTBaM, Mari Belajar PAI, and ARithmetic are constrained to formal sign systems, which are not the preferred mode of daily communication among the deaf. StorySign and Hand Talk, although technologically advanced, cater to European and South American audiences, respectively, and lack contextual and cultural localization for Malaysia. Bimo AR is innovative in AR integration but is general-purpose and does not support sign language acquisition. MyIsyARat thus emerges as a novel solution by filling the niche for an AR-based, culturally contextual BIM learning tool.

The comparison of features, including Operating System, Interface Design, User, Augmented Reality, and Quiz, between the applications is detailed in Table 2 below.

Table 2 *Features between Existing Applications*

Application	Operating System	Interface Design	User	AR (Yes/No)	Quiz (Yes/No)
KTBM AR	Android	Structured	Student/Teacher	Yes	Yes
KoTBaM	Android	Structured	Teacher	No	No
StorySign	Android	Cheerful	Children	Yes	No
Hand Talk Translator	Android/iOS	Playful	General Users	No	No
Bimo AR	iOS	Cheerful	Children	Yes	Yes
Mari Belajar PAI	Android	Cheerful	Student/Teacher	Yes	Yes
ARithmetic	Android	Cheerful	Student/Teacher	Yes	Yes

Based on Table 2, most applications operate on the Android platform, with only Hand Talk Translator supporting Android and iOS and Bimo AR limited to iOS. Interface designs vary, with some applications using structured layouts suitable for formal learning environments, while others adopt cheerful and playful designs to

appeal to children. AR is included in most applications, although a few do not support it. Similarly, quiz features are inconsistently applied, appearing in only a subset of the reviewed applications. The comparison reveals that none of the applications offer a complete set of features that combine platform flexibility, interactive design, AR, quizzes, and content specific to BIM. This comparison highlights a significant gap that MyIsyARat aims to address through its integrated and culturally relevant feature set.

2. Methodology

This project adopts the Multimedia Development Life Cycle (MDLC), which is particularly effective for AR-integrated educational tools. The MDLC involves six phases: Concept, Design, Material Collecting, Assembly, Testing, and Distribution.

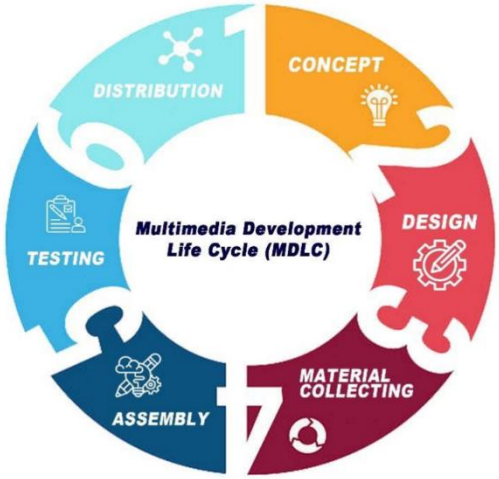

Fig. 1 *Multimedia Development Life Cycle (MDLC) Model* [20]

2.1 Concept

The concept phase identified the core problems in BIM learning, specifically accessibility, engagement, and cultural relevance. A literature review and field research revealed the need for visual-based, interactive content. BIM was selected as the focus language because of its conversational applicability and role as the community's natural language [2]. The decision to incorporate AR is based on its demonstrated effectiveness in enhancing memory recall, user satisfaction, and contextual understanding, particularly for visual learners [4]. The content areas include *Kata Ganti Nama*, *Ucapan*, and *Keluarga*, which were selected for their real-world relevance and high frequency of use in daily communication scenarios.

2.2 Design

The design phase involved the development of the app's user interface (UI) and creating animated 3D sign models. UI mockups were created using Canva, emphasizing clarity, accessibility, and visual appeal for Deaf and hearing users. For the 3D content, Blender was used to model and animate sign gestures corresponding to BIM vocabulary in three categories: *Kata Ganti Nama*, *Ucapan*, and *Keluarga*. Each animation was designed to loop smoothly and maintain anatomical accuracy to ensure the correct interpretation of signs. Visual feedback from experts in BIM was used to validate the design of each model before implementation.

2.3 Material Collecting

The development process began with collecting all necessary digital assets and development tools. The mobile application was built using Flutter within the Visual Studio Code environment, with user authentication implemented through Firebase using Google sign-in services. For the AR component, AR.js was used as a WebAR framework based on HTML, CSS, and JavaScript and was deployed using Netlify for online access. A customized AR marker was designed and hosted on GitHub to enable integration with the AR.js system. Three-dimensional models representing BIM gestures were sourced from open-access online repositories. These models were refined using Blender, where animations were added and visual details enhanced to ensure accuracy and appeal. Each model was exported in GLB format to support compatibility with WebAR. To complement the digital content, demonstration videos of BIM gestures were recorded by the development team for each topic. These videos were reviewed by experts, including teachers, to gather constructive feedback and ensure educational quality.

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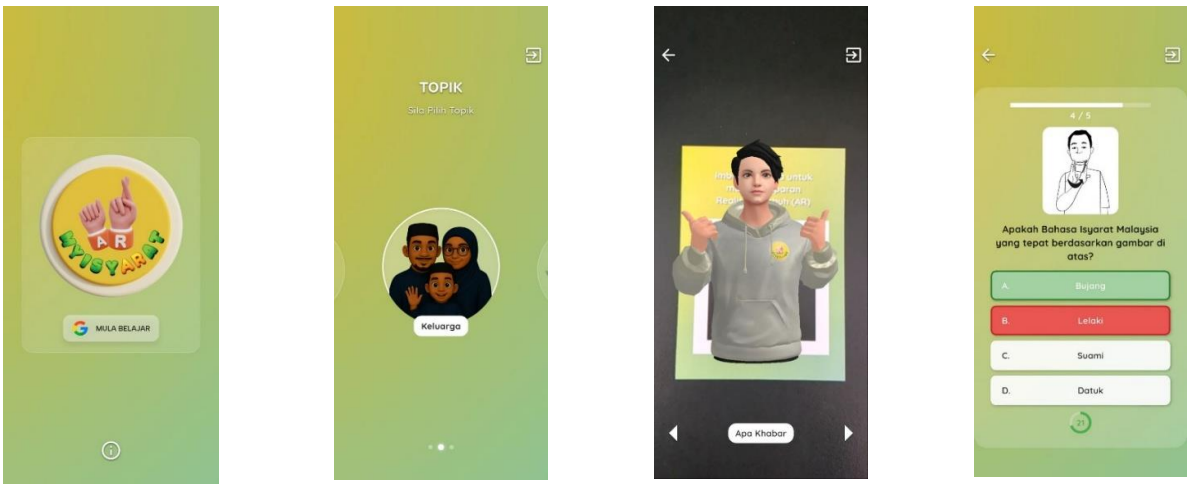
2.4 Assembly

All collected components were integrated into a complete and functional app in the assembly phase. The Flutter-based application was connected to Firebase to manage user authentication and access. The AR.js module, hosted on Netlify, was embedded into the app through a WebView component to enable in-app AR experiences. When a user scans a marker, the corresponding three-dimensional model is loaded and displayed in real-time. These models, organized into categories such as *Kata Ganti Nama*, *Ucapan*, and *Keluarga*, were animated using Blender and optimized for performance in the GLB format. Some app interfaces are shown in Fig. 2.



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

Fig. 2 *Some of the MyIsyARat interfaces (a) Login using Google account; (b) Horizontally scrollable menu of topics; (c) AR mode for subtopic; (d) Quiz mode for subtopic*

The customized marker hosted on GitHub ensures accurate model recognition and rendering. All multimedia elements, including AR scenes and BIM video demonstrations, were combined to create an engaging and user-friendly learning experience. The system was tested internally and refined based on expert feedback to ensure smooth interaction and substantial educational value.

2.5 Testing

User testing for the MyIsyARat application was carried out at *Sekolah Kebangsaan (L) Bandar Kluang*, involving a diverse group of participants, including teachers, and deaf and mute students, as well as hearing individuals who were interested in learning BIM as shown in Fig. 3.

(a) **(b)** **(c)**

Fig. 3 *MyIsyARat testing at Sekolah Kebangsaan (L) Bandar Kluang (a) Students testing the app; (b) App explanation; (c) Picture taken with students and teachers*

Participants interacted with the app's AR features and explored the BIM content to evaluate ease of use, engagement, and educational value. Teachers and subject matter experts shared structured feedback through a Google Forms, highlighting the app's inclusivity and potential to foster a greater understanding of sign language. The questionnaire employed a five-point Likert scale to measure respondents' level of agreement with each item. Scores ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). Insights and suggestions collected during this phase were instrumental in refining the application to suit users' learning needs better.

2.6 Distribution

MyIsyARat is currently undergoing the publishing process on the Google Play Store and will soon be available for free to all Android users.

3. Results

MyIsyARat underwent user testing and received feedback from a diverse group of users. Their comprehensive input on the application's usability, content quality, and user engagement was collected via a Google Forms questionnaire (see **Appendix A**) for analysis. Google Forms was chosen to enable broader participation and easier access across different locations. A demo video of the application was also embedded in the form to guide participants during the evaluation. A total of 32 respondents participated in the survey. The feedback was overwhelmingly positive, with users enthusiastic about the interactive and immersive learning experience.

3.1 Analysis

Based on Table 3, for each section, the mean score (in Equation 1) for every item was calculated to determine overall user perception. The mean was computed using the following formula:

$$\text{Mean Score} = \frac{(1 \times N_1) + (2 \times N_2) + (3 \times N_3) + (4 \times N_4) + (5 \times N_5)}{N} \quad (1)$$

where:

- N_1 to N_5 represent the number of respondents who selected scale points 1 to 5, respectively, and
- N is the total number of respondents for the item.

The interpretation of the mean scores is based on the following scale:

- 1.00 – 2.33 = Low
- 2.34 – 3.66 = Moderate
- 3.67 – 5.00 = High

Table 3 *MyIsyARat App's Usability, Content Quality, and User Engagement*

Section	Item	Likert Point					Mean Score
		1	2	3	4	5	
App Usability (AU)	AU1	0	0	4	17	11	4.22
	AU2	0	0	6	14	12	4.19
	AU3	0	0	5	17	10	4.16
	AU4	0	0	4	15	13	4.28
	AU5	0	0	5	13	14	4.28
						Average	**4.23**
Content Quality	CQ1	0	0	5	13	14	4.28
	CQ2	0	0	8	12	12	4.13
	CQ3	0	0	5	18	9	4.13
	CQ4	0	0	5	17	10	4.16
						Average	**4.18**
Engagement and Learning Experience (ELE)	ELE1	0	0	5	13	14	4.28
	ELE2	0	0	2	11	19	4.53
	ELE3	0	0	3	13	16	4.41
	ELE4	0	0	2	20	10	4.25
	ELE5	0	0	6	18	8	4.10
						Average	**4.31**

The average mean scores were 4.23 for App Usability, 4.18 for Content Quality, and 4.31 for Engagement and Learning Experience. These consistently high scores reflect strong user acceptance and satisfaction with the

MyIsyARat application. Thus, the app received highly positive feedback from most respondents, demonstrating its effectiveness and appeal across key areas.

3.2 Discussion

While overall user feedback on the MyIsyARat application was highly positive, several constructive suggestions were provided for future enhancement. Some users recommended expanding language support to cater to diverse user backgrounds better. Others suggested incorporating quizzes and more precise guidance or tutorials to help new users navigate the app effectively. Enhancing the visual design, particularly appealing to younger audiences, was also highlighted. These insights offer valuable direction for refining the app to ensure it remains inclusive, engaging, and user-friendly across all age groups and communities.

4. Conclusion

MyIsyARat has shown a meaningful impact in helping to close the communication gap between Deaf and hearing individuals in Malaysia. By combining culturally relevant content with a fun and interactive learning experience, this mobile app makes learning BIM more accessible to everyone. Built using the MDLC, the app brings sign language to life through 3D animations and AR, making learning easier and more enjoyable. Feedback from users of different backgrounds has been overwhelmingly positive, especially regarding usability, content, and overall experience. More than just a learning tool, MyIsyARat helps build understanding, empathy, and stronger connections between communities.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design****: Muhammad Irfan Alimun, Rafizah Mohd Hanifa;* ***data collection, development, and integration****: Muhammad Irfan Alimun, Hanief Haiqal Harizan, Muhammad Bazil Akid Rosdee;* ***analysis and interpretation of results / user testing****: Muhammad Irfan Alimun, Hanief Haiqal Harizan, Muhammad Bazil Akid Rosdee, Rafizah Mohd Hanifa;* ***draft manuscript preparation****: Muhammad Irfan Alimun, Hanief Haiqal Harizan, Muhammad Bazil Akid Rosdee. All authors reviewed the results and approved the final version of the manuscript.*

Appendix A: Questionnaires

Section A: Demographics
Q1: What is your age?
Q2: Gender
Q3: Are you (Deaf or Hard of Hearing/Hearing/Parent of Deaf Child/Educator/other)
Q4: Prior knowledge of *Bahasa Isyarat Malaysia* (BIM)
Section B: App Usability
Q1: App is easy to navigate
Q2: The instructions provided are clear and helpful
Q3: The AR features work smoothly on my device
Q4: The app interface is user-friendly and accessible
Q5: I encountered no major technical issues while using the app.
Section C: Content Quality
Q1: The signs demonstrated in the app are accurate and easy to understand
Q2: The 3D animations or AR visuals are clear and useful for learning
Q3: The categories (e.g. Pronouns, Greetings, and Family) are relevant and practical
Q4: The app uses culturally appropriate and respectful content
Section D: Engagement and Learning Experience
Q1: I enjoyed using this app to learn *Bahasa Isyarat Malaysia* (BIM)
Q2: The AR features made the learning experience more engaging
Q3: I feel more confident using basic *Bahasa Isyarat Malaysia* (BIM) after using this app
Q4: The app is helpful for both Deaf individuals and hearing users
Q5: I would recommend this app to others
Section E: Open-Ended Questions
Q1: What features did you like the most about MyIsyARat?
Q2: What improvements would you suggest for the app?
Q3: How do you think this app can help bridge communication gaps in your community?

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