



SignIt! An Android Game for Sign Bilingual Play

Roshni Poddar*
Microsoft Research
Bangalore, India
t-ropoddar@microsoft.com

Pradyumna YM*
Microsoft Research
Bangalore, India
pradyumnaym@outlook.com

Divya Prabha Jayakumar
Microsoft Research
Bangalore, India
jdivyaprabha12@gmail.com

Tarini Naik
Microsoft Research
Bangalore, India
t-naiktarini@microsoft.com

Punyat Tripathi
National Institute of Speech and
Hearing
Trivandrum, India
punyattripathi@gmail.com

Nabeel TP
National Institute of Speech and
Hearing
Trivandrum, India
nabeeltp05@gmail.com

Hemanth Reddy Yeddula
National Institute of Speech and
Hearing
Trivandrum, India
yeddulahemanthreddy@gmail.com

Pratyush Kumar
Microsoft Research
Bangalore, India
pratyush@cse.iitm.ac.in

Mohit Jain
Microsoft Research
Bangalore, India
mohja@microsoft.com

Manohar Swaminathan
Microsoft Research
Bangalore, India
manohar.swaminathan@microsoft.com

ABSTRACT

The Deaf or Hard-of-Hearing (DHH) community constitutes over 430 million people globally, with about 70 million of them using sign language as their primary means of communication. Learning sign language poses significant challenges, and researchers have explored the potential of digital games as educational tools for teaching sign language. However, existing educational games are limited to a narrow range of words and feature only single-player modes. Consequently, our objective was to design a sign language-based game that not only facilitates learning but also enables social gameplay and encourages user-generated content. In this work, we present *SignIt!*, an accessible quiz platform co-designed with the DHH community. *SignIt!* empowers DHH players to play sign language-based quizzes either individually or in competitive settings, as well as to create their own quiz content. Through a user study involving five DHH participants, we found *SignIt!* was deemed easy-to-learn, intuitive, and accessible by our participants. They expressed various motivations for using *SignIt!*, including passing time, learning quiz content, and connecting with friends.

*Both authors contributed equally to this work

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).
ASSETS '23, October 22–25, 2023, New York, NY, USA
© 2023 Copyright held by the owner/author(s).
ACM ISBN 979-8-4007-0220-4/23/10.
<https://doi.org/10.1145/3597638.3614484>

CCS CONCEPTS

• **Human-centered computing** → **Accessibility**; *Empirical studies in HCI*.

KEYWORDS

game, deaf, hard of hearing, multiple-choice question, creation, data, learning

ACM Reference Format:

Roshni Poddar, Pradyumna YM, Divya Prabha Jayakumar, Tarini Naik, Punyat Tripathi, Nabeel TP, Hemanth Reddy Yeddula, Pratyush Kumar, Mohit Jain, and Manohar Swaminathan. 2023. *SignIt! An Android Game for Sign Bilingual Play*. In *The 25th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '23)*, October 22–25, 2023, New York, NY, USA. ACM, New York, NY, USA, 4 pages. <https://doi.org/10.1145/3597638.3614484>

1 INTRODUCTION AND RELATED WORK

The Deaf or Hard-of-Hearing (DHH) community represents a significant portion, comprising over 5% or approximately 430 million individuals worldwide [14]. Among them, more than 70 million people rely on sign language as their primary means of communication. In recent years, researchers have recognized the potential of digital games in delivering engaging and effective sign language learning experiences [1, 3, 5, 8]. Sign language games can be broadly categorized into two types based on their interaction mechanisms: learn-by-view games and learn-by-practice games. Learn-by-view games present signing videos or avatars to guide players in learning new signs [2, 3, 6, 15], while learn-by-practice games encourage players to mimic signs and provide feedback to improve sign accuracy [1, 5, 12, 13].

However, existing sign language games have limitations. They typically focus on a limited set of words and/or phrases, and lack multiplayer modes that foster social collaboration and competition. To address these gaps, our research aimed to develop a game that not only facilitates learning but also enables user-generated content and multiplayer gameplay. Empowering players to create sign language content allows for diverse and engaging materials that other players can interact with and learn from. Furthermore, incorporating multiplayer competitive play motivates players to learn, resolves conflicts, and fosters positive attitudes towards peers [10, 11].

In this work, we present *SignIt!*, a sign language-based quiz platform inspired by popular quiz platforms such as Kahoot!¹ and Quizizz². Kahoot!, in particular, garnered billions of users by emphasizing engagement, participation, and motivation through competitive gaming experiences [18, 19], and by enabling users to create any quiz on their chosen topic. However, it primarily relies on text-based quizzes and lacks support for sign language quiz creation. *SignIt!* bridges this gap by enabling DHH users to play sign language quizzes individually or compete with others while also providing quiz creation capabilities. *SignIt!* was co-designed with input from the Deaf community to ensure its relevance and accessibility. *SignIt!* incorporates various features, including power-ups, leaderboards, coins, and badges, to enhance user engagement. To ensure its effectiveness, all aspects of the app were developed iteratively with feedback from DHH teachers and students. Moreover, great attention was given to designing visually appealing graphics and ensuring scalability to accommodate a large user base.

To evaluate *SignIt!*, we conducted a mixed-method user study involving five DHH participants. In two weeks, our participants played 255 quizzes (answering 744 multiple-choice questions) across various modes, and created 32 groups and 39 quizzes (containing 90 questions). Overall, the participants found *SignIt!* to be easy-to-learn, intuitive, and accessible. They expressed diverse motivations for using *SignIt!*, including passing time, learning quiz content, and connecting with friends.

2 THE DESIGN OF SIGNIT!

Below, we elaborate on the key features of *SignIt!*.

2.1 Play Quiz

When a player starts a quiz, they are taken to the question screen. This screen presents a question along with two to four answer options as sign language videos. Each video includes a hint button to toggle its corresponding caption. The captions serve as hints to create sign language to text mappings, supporting the player in discovering and learning new vocabulary in either the sign or the caption language while playing quizzes. The question screen also contains the total number of coins, the current question number, and two power-ups (Figure 1c). Each option has a radio button for selection of the answer. After selecting an answer, the answer analysis screen shows the question text and option texts, with the correct option highlighted in green and the incorrect option highlighted in red (Figure 1d). To assist with answering questions, *SignIt!* offers two power-ups - one that costs 500 coins and removes

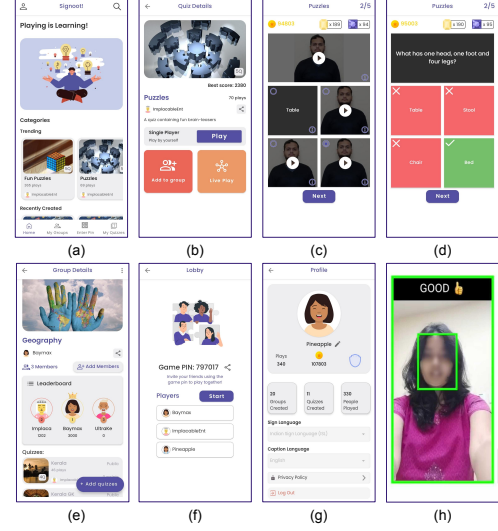


Figure 1: Screenshots of *SignIt!* (a) Home screen (b) Quiz Details screen (c) Question screen (d) Answer Analysis screen (e) Group details screen (f) Game lobby screen for live mode (g) User profile screen (h) Video recording interface

half of the incorrect options, and another that costs 1000 coins and removes all incorrect options. Tapping “Next” takes the player to the score screen, which displays their answer’s correctness, the score for the current question, and the overall total score. The scoring mechanism is as follows: each question is worth 1000 points, and players receive no points for incorrect answers. If a player takes more than 20 seconds to answer a question, twice the number of extra seconds $((\text{Time taken} - 20) \times 2)$ are deducted from their score, up to a maximum deduction of 300 points. Using a hint incurs a penalty of 40 points; however, once a hint is used for any video, there is no further reduction for using it again. Upon completing the last question, the player is awarded coins based on their performance. The number of coins awarded is equal to their total score divided by 10, rounded to the nearest hundred. Similar to Kahoot!, we implemented three quiz play modes named individual mode, group mode and live mode. These modes are detailed below:

Individual mode: In individual mode, players play quizzes alone and can replay them multiple times. We decided not to set a time limit on the questions, as research on Kahoot! [19] found that time limits reduced player reflection and led to rushed guesses.

Group mode: The purpose of groups is to collate multiple people and quizzes in a group to introduce a social element of competition among players. Similar to individual mode, group quizzes do not have a timer and may be played asynchronously. The cumulative points earned from group quizzes are showcased on the group leaderboard. This leaderboard presents the scores of all group members in descending order, motivating players to compete by participating in group quizzes. The details of the group mode are shown in Figure 1e.

Live mode: Live mode allows multiple players to participate in synchronous quizzes, where all players answer each question

¹<https://kahoot.com/>

²<https://quizizz.com/>

simultaneously. In *SignIt!*, the host (the player who started the quiz) also participates and the questions are displayed on all devices. To ensure a fair leaderboard across different questions, the same question appears on everyone's screen at the same time. Players can start a Live mode game by selecting a quiz and choosing the "Live mode" option. This creates a lobby with a randomly generated six-digit game PIN, which can be shared with other players to invite them to join the game.

2.2 Create Quiz

Players can create their own quizzes by adding the quiz name, tags, sign language, caption language, and a list of questions. In addition, they can add a quiz image, description, and set its visibility (public or private). When creating a new question, the create question screen has a similar layout to the question screen, with placeholders for the question and four options. To add a video and corresponding caption for each question or option, the user must tap on the respective placeholder. A valid question must have at least 2 options and the correct answer must be marked. To assist with creating questions, we included a repository of pre-made questions on topics such as Bollywood movies, sports, and Indian brands. This allows players to quickly add the text of multiple questions to their quiz and then edit them to include corresponding sign language videos. When a quiz is made public, players are awarded coins based on the number of questions in the quiz.

Recording Videos: The create question video recording interface provides players with prompts like "Move closer," "Move left," and "Multiple Faces" to guide the user until accurately positioned. Then, a three-second countdown begins, and the recording starts. During recording, the top right corner displays elapsed time. Question videos can be up to 30 seconds, while options are limited to 15 seconds. The recording stops and the video is saved when the time limit is reached.

The three Deaf co-authors created 11 quizzes on their favorite topics such as fun facts about their home state, riddles, computer science, etc., to populate some initial quizzes for the participants to play on *SignIt!*.

3 STUDY DESIGN

3.1 Procedure and Participants

The IRB-approved study was conducted remotely in India in July 2022 due to COVID-19. To be eligible, participants needed access to an Android smartphone and had to be 18 years of age or older. Five DHH participants (3 female, 2 male, age=21.8±0.74 years) fluent in ISL were recruited via email from the National Institute of Speech and Hearing (NISH). Among the participants, two had mild hearing loss, one had moderate hearing loss, and two had profound hearing loss. The majority (4) were from Kerala and one was from Delhi. Four participants had undergraduate degrees and one had completed high school.

The participants were added to a WhatsApp³ group with two co-authors for communication. Once they had installed the app, we conducted a 45-minute introductory session over Zoom to provide an overview of the research study and *SignIt!*. The participants

were asked to earn Level 1 of the first five badges by playing five individual quizzes, one group quiz, and three live quizzes, as well as creating one group and three quizzes.

After earning the badges, participants completed an online survey and participated in a 45-minute semi-structured interview over a video call. The survey included demographic questions and Likert scale ratings on the app's main features. The interview focused on the overall experience, motivation, challenges faced, and suggestions for improvement. All interviews were conducted via Zoom, either by a Deaf author in ISL or by a hearing author with ISL interpreters. Participants' consent was obtained and the interviews were recorded. They were asked to uninstall *SignIt!* after the interview. Interviews were transcribed and exact translations are used for quotes. Participants received an INR 700 (~10 USD) gift voucher for their participation.

3.2 Results

In our study, participants used the *SignIt!* app for an average of 12.8±1.3 days. They played 144 quizzes (answering 546 multiple-choice questions) in individual mode, 94 quizzes (answering 181 questions) in group mode, and 17 quizzes (answering 17 questions) in live mode, and created 32 groups and 39 quizzes (containing 90 questions), spending a total of 28 hours and 56 minutes on the app. The quiz creation resulted in the collection of 450 sign language videos (total duration of 29.5 minutes) recorded in real-world settings, which is crucial for the development of AI-based language technologies [4, 16].

During our interviews, participants mentioned various motivations for using *SignIt!*, including passing time, learning the quiz content, and connecting with friends. They found the user interface of *SignIt!* to be easy-to-learn, intuitive, and accessible. Furthermore, a majority of our participants (4) appreciated quizzes in sign language and shared their difficulties with English as a second language. This challenge has been well documented in accessibility literature [7, 17] as well. On average, participants played 51±26.82 quizzes each, exceeding the minimum threshold required for the study. This suggests that participants were intrinsically motivated to engage with *SignIt!*. While we did not formally test knowledge retention, some participants (3) reported anecdotally that they had learned about popular topics through the quizzes. Interestingly, P3 stated that she played particular quizzes to help with her exam preparation. From the log data, we found that P3 played 2 mathematics-based quizzes and 11 general knowledge-based quizzes on topics such as geography, sports, and computers. Similar to prior work [18], all our participants played several quizzes multiple times to improve their learning.

Interestingly, three out of five participants identified quiz creation as their favorite feature, despite it being the most complex task on *SignIt!*. Our participants reported two primary motivations for creating quizzes: providing content in sign language to the DHH community and gaining recognition. For example, *"To make a quiz... I think it's going to be great because it's something I made, and others will see it... Other people will click and see my video. I will automatically become famous."* – P2.

Challenges with using *SignIt!* included regional variations of sign language in the quizzes, insufficient time to record questions in quiz

³<https://www.whatsapp.com/>

creation, and unexpected app crashes during live play due to bugs. The challenge with regional variations is due to the existence of multiple dialects of Indian Sign Language (ISL), such as Bangalore-Chennai-Hyderabad Sign Language, Mumbai-Delhi Sign Language, and Kolkata Sign Language [9, 20].

4 CONCLUSION AND FUTURE WORK

In conclusion, we present *SignIt!*, an accessible quiz platform co-designed with the DHH community. *SignIt!* is an Android application that empowers DHH players to play sign language-based quizzes either individually or in competitive settings, as well as to create their own quiz content. We have focused on visually appealing graphics, scalability to accommodate a large user base, and interactive features such as power-ups, leaderboards, coins, and badges to enhance user engagement. Our initial user study with five DHH participants demonstrated the platform's usability, learning potential, and feasibility of sign language data collection. Future work includes implementing participant feedback to improve *SignIt!* and conducting a longitudinal study in the wild with a larger number of participants. Moreover, we will be exploring the potential for *SignIt!* to be used by hearing individuals learning sign language. We hope to expand our research through collaborations and increase real-world usage among diverse DHH communities.

ACKNOWLEDGMENTS

Thank you to all our participants for their time and patience.

REFERENCES

- [1] Nicoletta Adamo-Villani and Kelly Wright. 2007. SMILE: An Immersive Learning Game for Deaf and Hearing Children. In *ACM SIGGRAPH 2007 Educators Program* (San Diego, California) (SIGGRAPH '07). Association for Computing Machinery, New York, NY, USA, 17–es. <https://doi.org/10.1145/1282040.1282058>
- [2] Diego Roberto Antunes and Janaine Daiane Rodrigues. 2021. Endless Running Game to Support Sign Language Learning by Deaf Children. In *Universal Access in Human-Computer Interaction. Access to Media, Learning and Assistive Environments*, Margherita Antona and Constantine Stephanidis (Eds.). Springer International Publishing, Cham, 25–40.
- [3] Yosra Bouzid, Mohamed Ali khenissi, and Mohamed Jemni. 2016. The Effect of Avatar Technology on Sign Writing Vocabularies Acquisition for Deaf Learners. In *2016 IEEE 16th International Conference on Advanced Learning Technologies (ICALT)*. 441–445. <https://doi.org/10.1109/ICALT.2016.127>
- [4] Danielle Bragg, Naomi Caselli, John W. Gallagher, Miriam Goldberg, Courtney J. Oka, and William Thies. 2021. ASL Sea Battle: Gamifying Sign Language Data Collection. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) (CHI '21). Association for Computing Machinery, New York, NY, USA, Article 271, 13 pages. <https://doi.org/10.1145/3411764.3445416>
- [5] Helene Brashear, Valerie Henderson, Kwang-Hyun Park, Harley Hamilton, Seungyon Lee, and Thad Starner. 2006. American Sign Language Recognition in Game Development for Deaf Children. In *Proceedings of the 8th International ACM SIGACCESS Conference on Computers and Accessibility* (Portland, Oregon, USA) (Assets '06). Association for Computing Machinery, New York, NY, USA, 79–86. <https://doi.org/10.1145/1168987.1169002>
- [6] Raouf Chebka and Fathi Essalmi. 2015. A crosswords game for deaf. In *2015 5th International Conference on Information & Communication Technology and Accessibility (ICTA)*. 1–6. <https://doi.org/10.1109/ICTA.2015.7426880>
- [7] Franz Dotter. 2008. English for deaf sign language users: Still a challenge. *English in international deaf communication* (2008), 97–121.
- [8] Ryohei Egusa, Takahiro Nakadai, Tomohiro Nakayama, Fusako Kusunoki, Miki Namatame, Hiroshi Mizoguchi, and Shigenori Inagaki. 2016. A Full-Body Interaction Game for Children with Hearing Disabilities to Gain the Immersive Experience in a Puppet Show. In *Social Computing in Digital Education*, Fernando Koch, Andrew Koster, and Tiago Primo (Eds.). Springer International Publishing, Cham, 29–38.
- [9] William J. Frawley. 2003. Sign Language Linguistics. In *International Encyclopedia of Linguistics* (2 ed.), William J. Frawley (Ed.). Vol. 1. Oxford University Press, Oxford, 53–55.
- [10] Mohit Jain, Jeremy Birnholtz, Edward Cutrell, and Ravin Balakrishnan. 2011. Exploring Display Techniques for Mobile Collaborative Learning in Developing Regions. In *Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services* (Stockholm, Sweden) (MobileHCI '11). Association for Computing Machinery, New York, NY, USA, 81–90. <https://doi.org/10.1145/2037373.2037388>
- [11] David Johnson and R.T. Johnson. 2015. *Cooperation and Competition*. 856–861. <https://doi.org/10.1016/B978-0-08-097086-8.24051-8>
- [12] Jestin Joy, Kannan Balakrishnan, and M. Sreeraj. 2019. SignQuiz: A Quiz Based Tool for Learning Fingerspelled Signs in Indian Sign Language Using ASLR. *IEEE Access* 7 (2019), 28363–28371. <https://doi.org/10.1109/ACCESS.2019.2901863>
- [13] Jintao Nie, Yijun Zhao, Bing Yao, Zheng Xu, Jiayan Chen, Changchao Yu, Preben Hansen, Jianhui Liu, Jiadi Wang, Ge Yan, et al. 2022. SignFind: A Synchronized Sign Language and Chinese Character Teaching Game for Chinese Deaf Children Using Gesture Recognition. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts*. 1–7.
- [14] World Federation of the Deaf. 2018. Our Work. <http://wfdeaf.org/our-work/>.
- [15] Leigh Ellen Potter, Jessica Korte, and Sue Nielsen. 2012. Sign My World: Lessons Learned from Prototyping Sessions with Young Deaf Children. In *Proceedings of the 24th Australian Computer-Human Interaction Conference* (Melbourne, Australia) (OzCHI '12). Association for Computing Machinery, New York, NY, USA, 501–504. <https://doi.org/10.1145/2414536.2414613>
- [16] Advait Sridhar, Rohith Gandhi Ganesan, Pratyush Kumar, and Mitesh Khapra. 2020. INCLUDE: A Large Scale Dataset for Indian Sign Language Recognition. In *Proceedings of the 28th ACM International Conference on Multimedia* (Seattle, WA, USA) (MM '20). Association for Computing Machinery, New York, NY, USA, 1366–1375. <https://doi.org/10.1145/3394171.3413528>
- [17] Advait Sridhar, Roshni Poddar, Mohit Jain, and Pratyush Kumar. 2023. Challenges faced by the Employed Indian DHH Community. In *Proceedings of the 19th IFIP TC13 International Conference on Human-Computer Interaction (INTERACT)*. Springer.
- [18] Alf Inge Wang. 2020. *Dozens of studies show learning benefits of using Kahoot!* Retrieved 25/Aug/2022 from <https://kahoot.com/blog/2020/07/01/dozens-of-studies-show-learning-benefits-of-kahoot/>
- [19] Alf Inge Wang and Rabail Tahir. 2020. The effect of using Kahoot! for learning – A literature review. *Computers & Education* 149 (2020), 103818. <https://doi.org/10.1016/j.compedu.2020.103818>
- [20] Wikipedia contributors. 2023. Indo-Pakistani Sign Language. https://en.wikipedia.org/wiki/Indo-Pakistani_Sign_Language. Accessed on 4 May 2023.