

# PROVIDING IMMERSIVE SIGN LANGUAGE EDUCATION PROGRAM UTILIZING ANDROID TV PLATFORM AND AI TECHNOLOGIES FOR BETTER COMMUNICATION OF DEAF FAMILY

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## ABSTRACT

More than 90% of deaf children are born into hearing families. Unless the family learns sign language together, deaf children easily become isolated and may receive inadequate home education. This is the first social barrier deaf children must face.

To solve the above social problem, EQ4ALL designed a sign language education application for Google's Android TV platform in partnership with KT skylife, leading IP converged direct to home (DTH) broadcaster.

To provide an immersive education experience for both hearing and deaf family members, a web cam connected to a set-top-box is used to capture user signing with machine vision technology while a remote controller's microphone is used for voice-based dictionary.

The project shows that pay TV operators can use their set-top-box platform for environmental, social, and governance (ESG) activities.

## INTRODUCTION

Excluding age-related deaf and hard of hearing people as most of them are not registered, sign language is primary language for deaf and hard of hearing (DHH) people. According to a 2017 survey by the Korean Ministry of Culture, 65.9% of registered DHH people in Korea use Korean sign language as their primary language while 69.5% of them have difficulty using Korean.

There are 410 thousand registered DHH people in Korea while 466 million DHH globally. According to the World Health Organization (WHO), this will increase to 9 million DHH people by the year 2050.

DHH people suffer from unequal opportunities throughout their whole life.



**Figure 1 – Example of DHH Lifetime inequality**

Among these 5 areas of inequality (Figure 1), we focused on family communication as this is the first barrier for deaf children. More than 90% of deaf children are born into hearing families unless the whole family learns sign language, the deaf child will be isolated environment and receive an inadequate home education.

It was shown that the age of first language acquisition strongly affects second language. It means that the earlier deaf children learn sign language, the more chance they are becoming proficient in verbal language (Rachel I Mayberry, 2007)

An analysis of SAT-10 reading comprehension results showed that sign language fluent deaf students, mostly early sign language learners, had significantly higher scores than students without sign language proficiency (Iva Hrastinski & Ronnie B. Wilbur, 2016) which means early adoption of sign language leads to better academic achievement.

To solve the social problem above, we designed sign language education application for the Android TV platform.

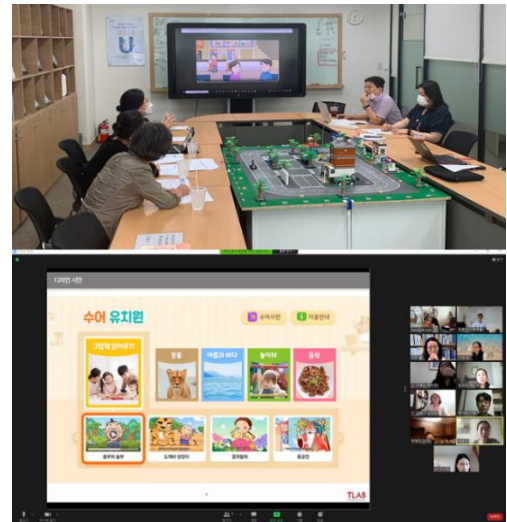
## THE PROJECT

Funded by the Korean Ministry of ICT and NIA (National Information Society Agency), EQ4ALL set up a consortium together with KT skylife, Korea's leading DTH broadcaster with 4.3 million of pay TV subscribers. Online education platform and contents company, Ubion ([eng.ubion.co.kr](http://eng.ubion.co.kr)) and android TV application developer company, TLab Convergence(<http://www.tlab.co.kr>) were invited to the project as consortium members for better content and UX quality.

Starting from the end of April 2021, we worked with the Korea National University of Welfare and two schools for deaf children for 3 months to plan education content and followed with technical design work by Ubion (Figure 2). The whole project was done within 8 months (Table 1).

Content was created for 12 categories: Kindergarten, Playground, Food, Shapes, Spring, Summer, Autumn, Winter, New Year Holidays, Family, Animals, and Vehicles. Each category has 4 sections each: reading, activities, concept learning and testing & review.

Interactive learner experience is critical for pedagogically stimulation in sign language learning (Georg Tschare, 2015). To develop an immersive education experience, we used two kinds



**Figure 2 - Contents planning meetings**

Task			Schedule (Month)							
			May	June	July	Aug	Sept	Oct	Nov	Dec
Development	Contents	Curriculum development								
		Contents development								
	Education Platform	Requirement analysis & design								
		development & testing								
	Service (App)	Requirement analysis & design								
		development & testing								
Test	Beta service	Participants recruiting, Service environment preparation								
		Service launching								

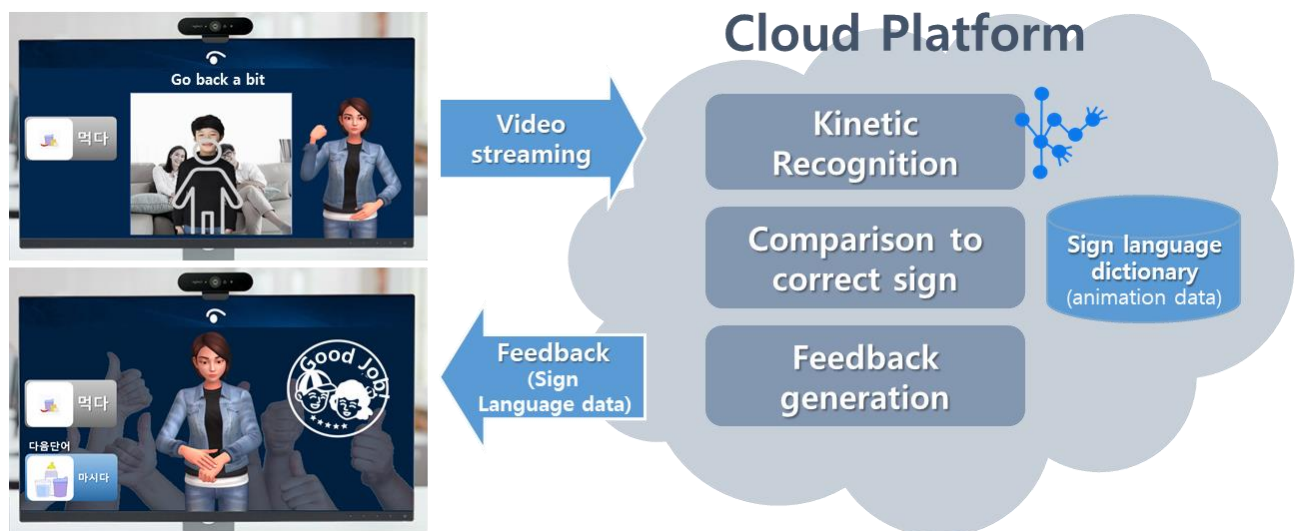
**Table 1 - Overall project schedule**

of AI technologies. A web cam installed into set-top-box captures user signing which is analyzed using machine vision technology to test user sign language and the microphone on the remote controller is used for voice-based dictionary search (Figure 3).



**Figure 3 - sign language testing (left) and sign language dictionary feature(right)**

As set-top-boxes with Android TV (version Pi and later) have plug-and-play web cam connectivity, we can stream the signing video directly to our cloud platform where the video can be analyzed and converted to dynamic pose data using OpenPose. Pose information is compared to the correct answer's pose data from our sign language dictionary database to evaluate the signing and provide feedback (Figure 4).



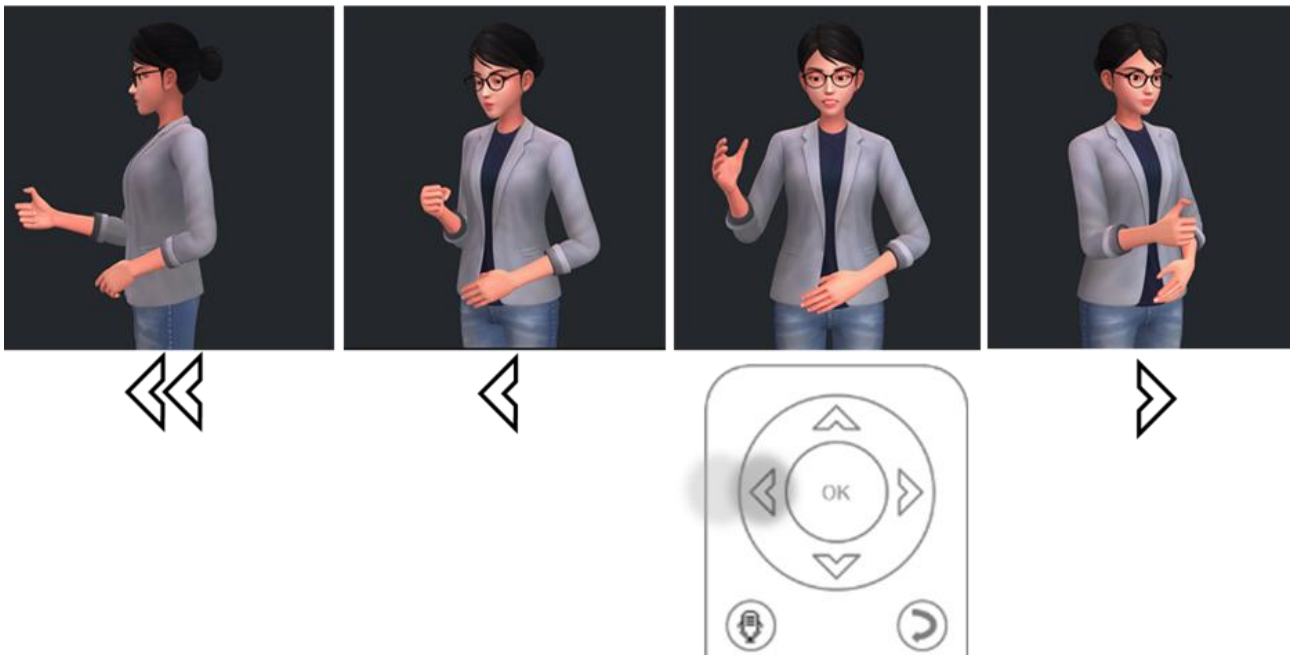
**Figure 4 - Sign language testing module diagram**

The sign language dictionary search feature was designed for the hearing family members to be able to search from the sign language vocabulary at any time with the remote controller. Utilizing the voice recognition (speech-to-text) feature of Android TV, the recognized text is sent to the cloud-based sign language dictionary system. The dictionary system then sends back the matched avatar sign language animation, and the animation is played on the TV app (Figure 5).



**Figure 5 - Sign Language dictionary search module diagram**

All signing avatars were designed to be rotated with the remote controller's arrow keys to help learn exact gestures from a 3-dimensional view (Figure 6).

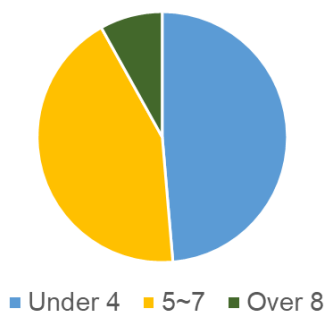


**Figure 6 - Rotation feature of avatar sign language with remote controller**

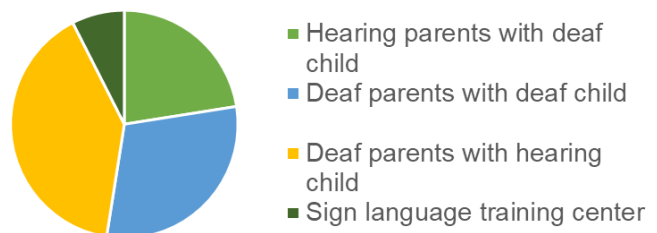
## THE RESULT

The beta service of the app was launched to 40 deaf families in November 2021 (Figure 7). 20 KT skylife's set-top-boxes for families with DTH coverage and 20 over-the-top(OTT) set-top-boxes for families without DTH coverage. Half of child participants were under 4 years of age and over 2/3 of participating families were hearing parents with deaf child while the remaining were CODA(Child Of Deaf Adults) families.

Age of target child



Family structure



**Figure 7 - Beta service target**

A guidebook was published together with the application for parents to have better learning experience together with their deaf child. After one month of beta testing, all participants completed a satisfaction survey. The average score for each evaluation category was over 90 out of 100 (Table 2). This survey shows that there is a strong need of this kind of service for deaf families (Figure 8) and that the Android TV platform's API and extensive cloud support allowed us to develop a reliable app on a tight development schedule.

Survey questions	Scores
Overall app satisfaction	90.8
Needs of app	95.8
App UX satisfaction	91.2
Reliability of app	93.3

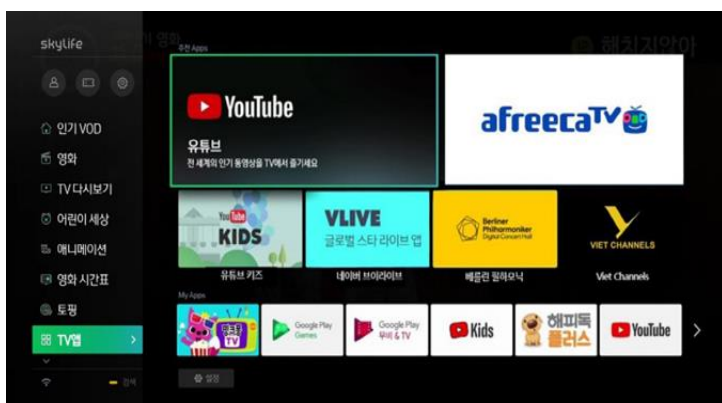
**Table 2 – User survey result**



**Figure 8 - Pics from beta service participants**

## THE NEXT STEP

The project was also funded by KT skylife as a social contribution effort, yearly providing 20 deaf families free of charge set-top-box, lifetime free of charge subscription, and a 55inch UHD TV (Figure 9).

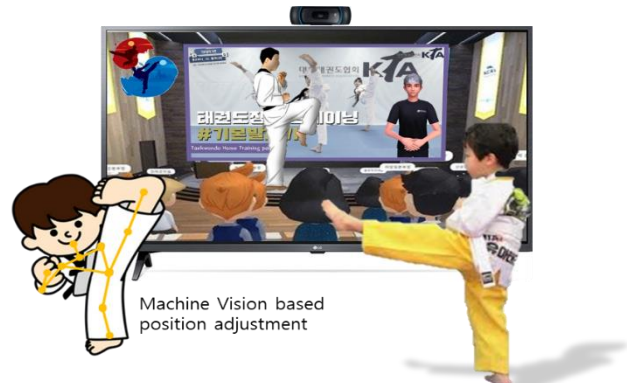


**Figure 9 – KT SkyLife's Android TV service and SET-TOP-BOX**

After 1 year of beta service, we will upload the app to the Android TV play store so that

deaf families can enjoy it on any android TV set-top-box (Over 70% of Korean pay TV operators use Android TV set-top-boxes).

We also plan to add more content in collaboration with Korean national museums. More specifically, National Aviation Museum of Korea will provide educational content related to aviation and transportation by the end of 2022. We are also in discussion with National Museum of Korea for the additional content. Other than museum contents, we plan to expand to sports and fine arts (Figure 10). As most deaf children do not have the same access to afterschool gym or art academies as most hearing children do, our long-term goal is to develop a metaverse app for TV which can deliver not only an effective learning experience but also allow deaf children to interact together in a virtual space.



**Figure 10 - Metaverse Taekwondo training concept**

## CONCLUSION

We presented a sign language education application and future plans for its development in this paper. The project showed how pay TV operators can use set-top-box platforms for ESG activities while targeting the UN's fourth sustainable development goal (SDG) of Quality education (Figure 11). The project also showed an good reference case of using machine vision like heavy AI technologies on android TV platform utilizing public cloud platform.

As per the results of this technical paper, we expect more social ventures to develop apps together with pay TV operators to solve various social problems such as digital medication



**Figure 11 – UN SDG's #4**

for depression and anxiety disorder and education platforms for developmental disability. Finally, we would like to share a video clip of the project for your reference at <https://youtu.be/Kh9GdLzQveo>.

## THE COMPANY EQ4ALL

EQ4ALL is a social venture founded in Nov. 2017 by two successful entrepreneurs from the online gaming and broadcasting solution fields with the mission statement of “Envisioning an equitable society with the latest technology.” The company is developing and improving machine learning based sign language translation technology to deliver more information and content to DHH people. Based on this translation technology, the company already completed various accessibility improving projects including a sign language announcement system for transportation & public spaces which can deliver sign language translations to passengers or visitors when there is emergency announcement (<https://youtu.be/BO3iSKMuVBI>), a mixed reality(MR)-based docent program with avatar sign language at museums(<https://youtu.be/Z-PAtPBHN2c>) and a signing avatar embedded barrier-free KIOSK project. The company consists of 24 designers, developers, and other contributors, including 4 deaf team members. Through the projects above, the company is pursuing the UN’s fourth and tenth SDGs.



## ACKNOWLEDGEMENT

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