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HangeulVR: an immersive and interactive Korean alphabet learning on virtual reality

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ABSTRACT

Learning a new foreign language promises numerous benefits, such are career advantage, culture exposure, and traveling opportunity. However, it comes with a cost of considerably significant efforts and time commitment. The challenge intensifies when dealing with languages characterized by distinctive scripts, such as Hangeul in Korean language. The requisite mastery of Hangeul characters precedes the exploration of fundamental linguistic elements, including grammar, pronunciation, speaking, and writing. In this research, we propose an innovative, immersive, and interactive methodology for Hangeul acquisition employing virtual reality (VR). Our study transports participants into a virtual environment, guided by a gamification framework designed to facilitate Hangeul learning. Participants are able to learn basic pronunciation, listening, and Hangeul writing, three fundamental aspects of learning the Korean alphabet. Empirical findings from our experiments show the potential of its usage, indicated by its system usability scale (SUS) of 74.4.

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1. INTRODUCTION

Learning a foreign language is a part of modern world requirements, as we need to interact and communicate with colleagues of different backgrounds. Traditional learning is often seen as uninteresting by language learners. In recent decades, the use of virtual reality (VR) in language learning has increased, mainly attributed to the increase in the motivation and engagement of the learners [1]. For education in general, VR has shown positive attainment of learning outcomes [2], [3], mainly because students can learn interactively with the subjects unlike the passive traditional methods [4], [5]. VR enables immersive learning that helps to improve students' enjoyment [6], [7] and long-term retention [8]. In addition to providing an authentic learning experience, immersive VR also facilitates students' cultural engagement [9]. The application of VR is prevalent in various fields, including medicine [10], engineering [11], agriculture [12], law [13], economics [14], and event military [15], to name a view.

Among many fields of education, foreign language learning is highly relevant to many learners. Students learn a new language before studying abroad [16]; employees study a foreign language prior to overseas relocation [17]; or even youngsters are interested in learning a new language for the sake of experiencing a new culture [18]. Regarding language learning, writing is a significant element, particularly writing in the form

of a script unique to a certain language, as in Korean language requires the learners to know its script called Hangeul. A previous study indicated that VR helps the writing learning process because it allows the students for authentic space to practice their writing skills [19].

In this paper, we introduce a novel way of learning the Korean alphabet by developing a VR-based learning media. The users learn how to read, write, and understand the sound of Korean alphabet in the proposed work. The VR-based application also provides an assessment scheme throughout the learning process, ensuring that students achieve the learning outcomes of a certain topic prior to moving forward to learn another topic. We also employ gamification to increase the engagement of the users. For example, in order to unlock the next topic, students have to complete a series of tests. In addition, the user is directed to a new location in order to learn the next topic. Our work, dubbed HangeulVR, allows students to learn Korean alphabets in various aspects: how to write them, how they sound, and how to read them. On each topic of the learning materials, apart from learning, students are also asked to complete a test, to assess the attainment of the learning objective of each chapter of the VR-based game. To evaluate the usability of our proposed HangeulVR, we performed a system usability scale (SUS) test. The average score given by the participants after trying our HangeulVR was 75.4, indicating that our VR-based learning environment is relatively easy to use for Korean alphabet learning. The score also implies that HangeulVR has high potential in helping the students learn the Korean alphabet better.

2. BACKGROUND

2.1. Korean alphabet

Hangeul is a writing system used throughout South Korea. It is developed by King Sejong in order to help common people to be able to write and read due to Hangeul's simplicity. Hangeul is an alphabet; it consists of a set of vowels and consonants. It has 10 basic vowels and 14 fundamental consonants, making a total of only 24 characters. Each syllable is written in a single block, consisting of consonant(s) and vowel. A single block can consist of from two to four characters [20]. The list of the Hangeul characters is shown in Figure 1 [21].

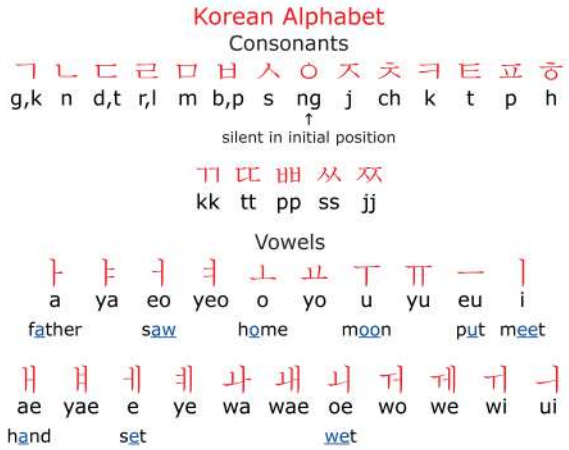


Figure 1. Top row: 14 basic consonants; second row: 5 double consonants; third row: 10 basic vowels; and last row: combined vowels of Hangeul

2.2. E-learning

E-learning is a method of education delivered electronically, usually over the internet. It offers a flexible and convenient learning experience, enabling students to engage with course materials, instructors, and peers from any location and at any time [22]. Acquiring proficiency in a foreign language through e-learning brings several advantages [23]. Firstly, e-learning provides individualization of the learning process. Students have the flexibility to progress at their own pace and on a schedule that suits them. Some students might learn better at night, while others prefer learning over the week-end or in a quiet cubicle in the library. E-learning can adjust each student's preference. Secondly, it also offers mobility. E-learning enables the users

to access its content of education from various places using their own devices. Students do not need to sit down at the same classroom to learn a particular subject. Thirdly, Thirdly, e-learning can be a more cost-effective option compared to traditional classroom learning, as it eliminates the need for expenses related to travel and accommodation. Lastly, e-learning has the potential to be more attractive than traditional classroom methods via attractive packaging. Various learning materials (videos, reading material, illustrations, and sounds), when successfully combined, can capture learners' attention and deliver knowledge to them.

2.3. Virtual reality

VR is a technology that allows users to experience a simulated environment that feels like the real world. It is achieved by using a headset that tracks the user's movements and displays a 3D image of the virtual environment in front of their eyes. The user can interact with the environment using hand-held controllers or other input devices [24].

The components of a VR system include a headset, a computer or mobile device to run the software, and input devices such as hand-held controllers or gloves [25]. When interacting within a VR world, a user is placed in a spatially realistic virtual environment, thanks to the high immersion offered by the system. The head-mounted display (HMD) is equipped with a head-tracking system, allowing the user to interact with the virtual world, as the rendered view is dynamically produced depending on the head movement. It provides realism within the virtual environment [9].

In the context of language learning, VR can be a powerful tool for improving learners' language skills. Immersive VR enables direct interactions with people and objects that are physically out of reach in the real world. Moreover, VR also facilitates a safe environment for learning, such as in the case of practicing language skills without fear of embarrassment or failure. In addition, VR has the potential to increase the students' participation and motivation during the learning process, since they can interact immersively with the virtual world [26]. By immersing learners in a virtual environment where they can interact with native speakers and practice their language skills in a realistic setting, VR can help learners to develop their listening, speaking, and comprehension skills [24].

3. HANGEULVR, VR-BASED HANGEUL LEARNING

In this section, we introduce the development of the HangeulVR. We first describe the content of the course, which is the Korean alphabet, that is integrated within the HangeulVR. An important aspect of this step is in designing the curriculum, i.e. how to categorize the alphabet into smaller groups such that they are easier to understand. The second stage is integrating such content to VR setup so that learners can take advantage of the immersive experience in VR to accelerate their learning. After that, in the third subsection of this chapter, we describe the gameplay of the application. This describes how the users navigate around the application to gain new knowledge of the Korean alphabet. Some concepts of gamification are also integrated in the gameplay. Lastly, we describe how the assessment is conducted to measure the attainment of the learning goals.

3.1. Pedagogical approach

In order to help students learn the Korean alphabet, we developed a VR-based application, referred to as HangeulVR. In this learning environment, we teach students the basic concepts of the Korean alphabet, such as how to read, pronounce, and read them. We also accompany the learning environment with necessary assessments to ensure the attainment of learning objectives.

As described earlier, the Korean alphabet consist of 14 basic consonants and 10 primary vowels. In addition to that, they also have 5 double consonants and 11 conjugate vowels. Therefore, there are 40 characters that learners need to study to understand Korean. To help students in learning, we divide and organize the Korean alphabets into several categories. They are (a) single vowels, (b) double vowels (category 'y'), (c) double vowels (category 'w'), (d) basic consonants, (e) modified consonants, and (f) double consonants. In addition to that, HangeulVR also teaches them how to write Korean syllable, which normally consist of a collection of consonant(s) and vowel. We group them into 3 categories, which are (a) consonant-vowel syllables, (b) consonant-vowel-consonant syllables, and (c) consonant-vowel-consonant-consonant syllables. A more elaborate description is provided in the Table 1.

Table 1. List of contents in this VR-based learning system

No	Chapter	Content
1	Single vowels	Students are to learn the following characters: ㅏ, ㅓ,ㅗ,ㅜ,ㅡ, ㅣ, ㅔ, and ㅐ
2	Double vowels ('y')	This section includes the following characters: ㅑ, ㅕ,ㅛ,ㅠ,ㅢ, ㅖ, and ㅒ
3	Double vowels ('w')	The vowels that belong to this category are: ㅘ, ㅝ, ㅚ, ㅟ, ㅙ, and ㅞ
4	Basic consonants	They are 10 most common consonants, i.e., ㄱ,ㄴ,ㄷ,ㄹ,ㅁ,ㅂ,ㅅ,ㅇ,ㅈ,and ㅎ
5	Modified consonants	The characters in this category are ㅋ,ㅌ,ㅍ,and ㅊ
6	Double consonants	In Hangeul, double consonants include: ㄲ,ㄸ,ㅃ,ㅆ,and ㅉ
7	Syllable: C+V	Students learn a basic syllable consists of two elements, such as 가,내, and 왜
8	Syllable: C+V+C	A more complex syllable consisting of 3 characters, like 밥, 선, and 한
9	Syllable: C+V+C+C	Special syllables with two consonants at the end: 값, 앉, and 닭

3.2. Hardware for application development

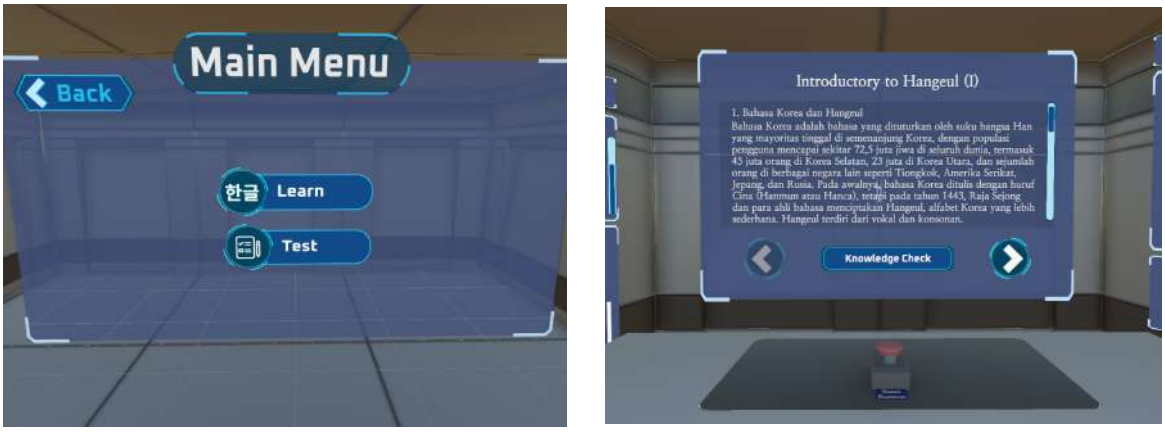
In this section, we will elaborate on the hardware setup for this research. We detail the hardware used for the application development and also we describe the hardware to deploy the VR application. In this research, a Lenovo V14-IIL laptop was used, equipped with the Windows 11 operating system, an Intel(R) Core(TM) i5-1035G1 CPU @ 1.00 GHz processor, an NVIDIA GeForce MX330 GPU, and 12 GB of memory. This laptop was utilized to run various software required for application development, including Unity and Visual Studio Code. Additionally, it was used for data analysis and graphical processing.

VR device. The VR device used for testing and implementing the VR-based game application under development was the meta quest 2. This device is a consumer-level all-in-one VR headset, offering an affordable VR experience. Powered by the Qualcomm® Snapdragon™ XR2 platform and 6 GB of RAM, the Quest 2 provides significant improvements in processing power and AI capabilities. Its resolution of 1832 x 1920 pixels per eye, with support for a 90 Hz refresh rate, delivers clearer and more realistic VR visuals. The new controllers are designed for better ergonomics and longer battery life. Meta quest 2 also grants access to a vast quest content library and is compatible with Oculus Link for enhanced PC VR experiences.

3.3. Gameplay

As the student step into the learning environment, as indicated by Figure 2, the main menu greets him with two options to choose between learning the Hangeul (Figure 2(a)) or taking a test on it (in case the student has sufficient prior knowledge, Figure 2(b). In most cases, the student is expected to choose the option to learn the Hangeul. In order to learn, the student has to enter a specified room where he learns the Korean alphabet. The player needs to learn a certain character in each room: how to read, write, and pronounce it. The order of which character to learn is set up according to Table 1 shown previously, e.g. student is taught about single vowels prior to double vowels.

To learn a specific character as indicated by Figure 3, the VR-based e-learning system displays the character and the description of how to pronounce the character, as shown in Figure 3(a). In addition, it also displays a button when clicked prompts the sound of such a character. A particular word in Bahasa Indonesia (the mother language of the target user) is shown to show the pronunciation of the word. The shape of the character is shown in the center of the screen as well. That is the content of each room for learning. In order to level up, student needs to move to another room. To do so, the students needs to pass a series of post-tests from each room. Figure 3(b) shows an example of listening question. Student needs to choose which button that plays the correct pronunciation of the shown character. For a writing test, the student has to draw the character, in which the system detects whether the writing is accurate, as shown in Figure 3(c). If the player answers them correctly, he can learn the next character. Otherwise, she has to redo the test (with different set of questions). This continues until the player completes all characters within the room.



(a) (b)

Figure 2. The main menu of the HangeulVR, where (a) option for learning or test and (b) a short intro to Hangeul

3.4. Learning materials

The focus of our VR-based HangeulVR application is to help students learn the Korean alphabet. Particularly, in three main areas of language proficiency, which are pronunciation, listening, and writing, as shown in Figure 3. Pronunciation. The one of most fundamental element in learning a foreign alphabet is understanding how a certain character is pronounced. This section of the module tells the learners how to pronounce each character of the Korean alphabet. An example of the visual in VR is shown in Figure 3(a). A Korean character is shown in the virtual world to the user, along with a textual explanation of how it should pronounced and a recording of the correct pronunciation of the character.

Listening. A related aspect of Korean alphabet learning is identifying the sound of a character. During the learning, the user is prompted to a certain character and is asked to choose which one is the correct pronunciation. In another setting, a recording of the pronunciation of a character is played and the learner is asked to identify what Korean alphabet it is. Figure 3(b) shows an example of a test for students for listening: a set of buttons when pressed play the sound of Hangeul character.

Writing. Another important aspect of learning is writing, particularly if a certain language has its unique writing, as in the Korean language. In this VR-based learning environment, we take advantage of its immersive setting. Users can use the VR hand-tracking to write the Korean alphabet as prompted. Our system also has a checking system to test whether the user's writing is correct or not. If it's correct, it is marked accordingly; and if it's wrong, feedback is also shown. The visual of writing practice is shown in Figure 3(c).

(a) (b) (c)

Figure 3. Three main aspects of Korean language learning that are covered in this module: (a) pronunciation, (b) listening, and (c) writing

3.5. Assessment

In order to assess the attainment of learning outcomes, the student is asked to take an assessment after each chapter (Figure 4). Once the test is completed, then the next chapter is unlocked for the user to learn. As the goal of the VR-based learning application is to help users read and write Hangeul, the assignment is designed accordingly. The test is built upon reading, writing, and listening to ensure the user learns the Korean alphabet accordingly. The test itself is randomized in each section. An example of the test question is shown in Figure 4(a). The system is also equipped with testing map (Figure 4(b)) to guide the user of which tests she/he has completed and which were still to be done.

(a)

(b)

Figure 4. Assessment section of the HangeulVR, where (a) knowledge about Hangeul is tested and (b) list of need-to-take assessment are shown

4. RESULTS AND DISCUSSION

To evaluate the usefulness of our proposed VR-based Korean alphabet learning environment, we performed a usability test using an SUS test. Usability, in general, can be described as an assessment of how easy user interfaces are to use. The SUS is a widely used tool for evaluating the usability of software, websites, and other systems. It provides a quantitative measure of the perceived usability of a system, helping developers and designers assess user satisfaction and identify areas for improvement.

We gathered 8 participants whose profile matches the target users of HangeulVR. Our participants are university students, whose ages are between 18 to 25 years old, 5 male and 3 female students. Participants were asked to use the HangeulVR, navigate around the system, and learn the Korean alphabet using the VR-based application. Figure 5 shows participants experiencing our HangeulVR and evaluating the application using SUS. Upon the completion of performing the tasks, they were asked 10 questions related to the usability of

the application. For each question, users can give a score between 1 to 5. The list of 10 questions used for our HangeulVR are shown in Table 2. A larger score indicates better performance on the odd-numbered questions, while for the even-numbered questions, a smaller score is preferred. We obtained an average score of 74.4 (as shown in Table 3) from the SUS test, indicating that application is easy to use for Korean alphabet learning. In a usability study, a mean score above 71.4 is considered good [27]. Therefore, we can conclude that our novel HangeulVR passed the usability test and has high potential for usage in Korean alphabet learning. This experiments indicate that the users are comfortable in using the VR-based application to learn Korean alphabet, HangeulVR. Most users gave 70 or more on the SUS evaluation, indicating the potential use of HangeulVR for learning Korean alphabet.

Figure 5. Users performed a usability test on HangeulVR

Table 2. Questions in the SUS test

No	SUS questions	Score	Note
1	I think that I would like to learn Hangeul using this VR app.	1-5	Larger is better
2	I found the VR app unnecessarily complex for learning Hangeul.	1-5	Smaller is better
3	I thought the VR app was easy to use when learning Hangeul.	1-5	Larger is better
4	I think that I would need the support of a technical person to learn Hangeul using this VR app.	1-5	Smaller is better
5	I found the various functions in this VR app were well integrated for learning Hangeul.	1-5	Larger is better
6	I thought there was too much inconsistency in this VR app for learning Hangeul.	1-5	Smaller is better
7	I would imagine that most people would learn Hangeul quickly using this VR app.	1-5	Larger is better
8	I found the VR app very cumbersome to learn Hangeul.	1-5	Smaller is better
9	I felt very confident using this VR app to learn Hangeul.	1-5	Larger is better
10	I needed to learn a lot before I could get going with this VR app to learn Hangeul.	1-5	Smaller is better

Table 3. SUS score from each participant

Participant ID	1	2	3	4	5	6	7	8	Average
SUS score	80	55	70	70	80	82.5	87.5	70	74.4

5. CONCLUSION

Learning a foreign language is indispensable in this globalized world. The task is ever greater when the language has its own script or alphabet, such as the Korean language. In this work, we devised a new learning system for the Korean alphabet, based on VR technology. Our system is equipped with 3 main aspects of alphabet learning, namely: pronunciation, listening, and writing. Our goal is to make learning more interactive and motivating, two components that VR is known to be great at. We evaluated the usability of our VR-based system, HangeulVR, using SUS on its potential users. The result shows a score of 74.4, indicating the potential of HangeulVR for Korean alphabet learning.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Ahmad Nasikun	√	√		√	√		√	√	√	√		√	√	√
Muhammad Fadhil Mahendra		√	√	√	√	√			√		√			
Achmad Rio Dessiar	√			√		√		√		√		√		√

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal Analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject Administration
Fu : **Fu**nding Acquisition

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, Ahmad Nasikun, upon reasonable request.

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