Young Foreign Language Learners’ Engagement and Motivation in Augmented Reality-based Vocabulary Learning*

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The potential of using augmented reality (AR) to create constructive learning opportunities in second language classrooms has been widely acknowledged. This understanding is based on the claim that ubiquitous learning paradigms, like AR-based instruction, motivate learners to engage in second language learning. To investigate the engagement and motivation of English as a foreign language learners in non-AR and AR-based vocabulary learning conditions, we performed a series of t-tests on a sample of third-, fourth-, fifth-, and sixth-grade students (n = 38, female = 18 students, mean age = 10.4 years old) whose engagement and motivation were assessed using the four scales of flow state (control, attention focus, curiosity, and internal interest). Moreover, a focus group interview was conducted on five students who were engaged in the AR-based instruction. The results of the flow questionnaire and focus group interview indicated that the AR-based instruction fostered higher interest and curiosity among young learners as compared to the non-AR-based instruction. These findings suggest that AR-based interventions designed to enhance young learners’ motivation to learn English as a foreign language can be beneficial.

Key words: augmented reality, vocabulary learning, engagement, computer-assisted language learning motivation
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I. INTRODUCTION

The establishment of a knowledge- and information-based society with easy access to mobile internet services has led to shifts in learning paradigms and the emergence of new learning environments (Jung, 2014). For example, the paradigm of computer assisted language

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learning (CALL) has shifted from electronic learning (e-learning) to mobile learning (m-learning), and, most recently, to ubiquitous learning (u-learning) (Yahya, Ahmad, & Jalil, 2010). Chen, Chang, and Wang (2008) suggested that there has been a corresponding shift in research interest. U-learning can be defined as a paradigm that involves situated learning through continuous communication with and connection to informational resources in everyday contexts (Jung, 2014).

Many researchers have suggested that augmented reality (AR) is an effective technology for establishing a u-learning environment (Dede, 2011; Huang, Chen, & Hsu, 2019; Santos et al., 2016). Azuma (1997) describes the nature of AR technology as combining real-world objects with virtual objects, involving interactions in real time, and registering the combinations of real-world and virtual objects in 3D space. These characteristics of AR enable the presentation of learning content in real environments and help to create stronger connections between content and context (Santos et al., 2016).

The benefits of AR technology as a learning tool have been discussed by many educational researchers in various fields such as science, math, art, and language learning (Bacca, Baldiris, Fabregat, & Graf, 2014; Bujak et al., 2013; Di Serio, Ibáñez, & Kloos, 2013; Ibáñez, Di Serio, Villarán-Molina, & Delgado-Kloos, 2014). Many researchers agree that AR can be helpful in motivating students. However, only few studies have examined the engagement and motivation of upper elementary school students in an AR-based language learning context. Thus, investigating the effectiveness of AR-based instruction with this understudied population of learners is crucial to better understanding which conditions garner preadolescent students’ engagement and motivation. Therefore, the current study employed a randomized control trial with a sample of upper elementary school-age learners to validate the potential benefits of AR in a u-learning environment.

II. LITERATURE REVIEW

1. Changes in Learning Paradigms

There has been a huge demand for effective applications of information and communication technology in the field of language learning. According to Jung (2014), the demand for alternative learning materials in various fields of education was a result of the establishment of a knowledge- and information-based society with easy access to mobile
internet services. Jung claimed that this increased demand has also led to shifts in learning paradigms from m-learning to u-learning and the emergence of new learning environments.

Shifts in learning paradigms have been studied by many researchers in the realm of CALL (Golonka, Bowles, Frank, Richardson, & Freynik, 2012; Jung, 2014, 2016, 2017; Kukulska-Hulme & Shield, 2008; Ogata & Yano, 2003; Yahya et al., 2010). Yahya et al. (2010) claimed that learning paradigms have shifted from traditional learning to electronic learning (e-learning) to mobile learning (m-learning), and finally, to u-learning. Chen et al. (2008) claimed that research topics have also changed in relation to these shifts in learning.

Jung (2016) defined e-learning as an environment in which learning happens with any kind of electronic system that supports learning. The system does not necessarily need to be connected to the Internet. For example, a television program on language learning can be considered an e-learning tool. As an extension of e-learning, m-learning includes the application of handheld devices in mobile environments (Kukulska-Hulme & Shield, 2008). The concept of mobility in m-learning is not limited to devices, but also refers to the mobility of the learner.

Moving forward from m-learning, u-learning is the newest learning paradigm that is being studied in CALL. Jung (2017) claims that u-learning is different from m-learning in that it focuses more on learners’ situation by using information from learners’ contexts. The term ‘u-learning’ is used by Jung (2014) to refer to a paradigm that involves learning resources (networks) offering communication and connectivity anytime and anywhere, through the use of technologies such as smartphones, tablet PCs, and smart PCs.

Many researchers agree that AR is a useful system for supporting u-learning (Dede, 2011; Huang et al., 2019; Santos et al., 2016). Dede (2011) stated that AR can support u-learning in authentic environments. This view is supported by Santos et al. (2016) who writes that the role of AR in u-learning is to display learning content in real environments and thus create stronger connections between content and real environments.

2. Augmented Reality Technology

AR is often confused with virtual reality (VR), as both are forms of immersive technology that are among the most cutting-edge technologies in language teaching (Blyth, 2018; Burston, 2013; Kessler, 2018). Azuma (1997) outlined three characteristics of AR, characteristics which have become widely cited in many educational fields to establish a better understanding of AR. First, AR combines real-world objects with virtual objects. Second, AR enables learners to interact in real time. Third, AR requires that the combination of real and virtual space be
registered in 3D space. As these characteristics demonstrate, AR can be understood as a system that does not completely replace reality, as is the case with VR. Milgram and Kishino’s (1994) reality-virtuality continuum is a widely cited framework that visualizes a scale that spans from the real-world environments to completely virtual environments. As shown in Figure 1, AR is closer to real-world environments than VR.

Therefore, although VR and AR are often used in similar contexts, they have different characteristics and thus have different implications for teaching. Some researchers in the field of language learning have tried to define AR in comparison with VR (Blyth, 2018; Godwin-Jones, 2016; Kessler, 2018). According to Blyth (2018), AR refers to an environment in which simulations of language use take place in authentic contexts, allowing the digital world to be merged with the real world. Unlike VR, AR does not block learners’ view of their actual environment (Godwin-Jones, 2016). Kessler (2018) suggested that these characteristics of AR enable learners to be engaged in a space that is familiar yet new.

![Reality-Virtuality Continuum](image)

(FIGURE 1) Reality-Virtuality Continuum (Milgram & Kishino, 1994, p. 1323)

3. Motivation and Augmented Reality in Language Learning

Among the many psychological factors that affect second language learning, motivation is believed by a large number of researchers to play an essential role (Dickinson, 1995; Dörnyei, 1994; Gardner & MacIntyre, 1991; Masgoret & Gardner, 2003; Zhang, Lin, Zhang, & Choi, 2017). Among several models that analyze learner motivation, the model of intrinsic and extrinsic motivation has received much attention due to its relevance to language teaching (Chang, 2005).

Extrinsically motivated learners are those who engage in learning to receive extrinsic rewards such as good grades or to avoid punishment (Dörnyei, 1994). According to Deci and Ryan (2010), intrinsically motivated learners perform a novel and challenging activity for its

12 Young Foreign Language Learners’ Engagement and Motivation in Augmented Reality-based Vocabulary Learning
inherent satisfaction. If a second language learner is motivated intrinsically, the positive feelings resulting from the act of learning itself will foster a sense of second language competence. This feeling of competence can allow learners to maintain their efforts in learning a second language regardless of external rewards.

Many empirical studies have shown that motivation can predict successful language learning in a variety of contexts such as English classrooms in Japan, Canada, and China (Noels, Clément, & Pelletier, 2001; Oga-Baldwin & Nakata, 2017; Wen, 1997). Although many researchers have found that intrinsic motivation is closely related to language achievement, Genc and Aydin (2017) found only a moderate level of correlation between language achievement and intrinsic motivation in a Turkish language classroom.

Many researchers consider motivation to be a significant factor in second language acquisition, but few studies have examined the role of motivation in vocabulary learning (Zhang et al., 2017). Many studies have shown that a learner’s motivation is not static and that it declines over time (Gardner, Masgoret, Tennant, & Mihic, 2004; Tseng & Schmitt, 2008). Tseng and Schmitt (2008) maintained that this dynamic characteristic of motivation is relevant for vocabulary learning since learners must study vocabulary over a long period of time in order to acquire enough vocabulary words and understand them in-depth. Several researchers have confirmed the significant role of motivation in vocabulary learning in foreign language classrooms (Fontecha & Gallego, 2012; Zhang et al., 2017; Zheng, 2012).

Under AR-based learning environments, a few researchers have focused on student’s motivation in learning languages. For example, in their descriptive research, Solak and Cakir (2015) studied how Turkish undergraduate students are motivated when AR technology was used in vocabulary learning. A measure of the motivational level revealed that AR technology supported increasing motivation toward vocabulary learning. Solak and Cakir (2015) argued that the studies of AR in the language learning field are at the beginning stages and that future research needs to incorporate new AR applications on various age groups.

A few studies have shown similar findings with younger learners (Barreira et al., 2012; He, Ren, Zhu, Cai, & Chen, 2014), but none of these studies have investigated the cause of the differences in test scores between AR and non-AR groups. For example, He et al. (2014) used an AR mobile application to teach 20 preschool children in China who were assigned to a traditional teaching method group (i.e., word card) and an AR-based teaching method group. Students’ attitudes toward the teaching method could not be gauged because the participants were too young to be able to report their attitudes; hence, on the teacher was interviewed after the treatment. In addition, Barreira et al. (2012) used an AR-based matching game in their study.
to teach English vocabulary to 26 students aged from seven to nine years old. The students were divided into AR-based and traditional teaching method groups. The researchers asked students to fill in a 5-point Likert scale questionnaire composed of a single item that asked how easy the interaction with AR-based game was. Half of the students answered that the learning experience with AR game was effortless and straightforward. Notwithstanding, the researchers acknowledged the inconclusiveness of the results due to a small sample with only 13 students in each group.

Most recently, Ibrahim et al. (2018) adopted Microsoft HoloLens¹, a head-mounted AR display to determine how AR-based vocabulary learning material is beneficial for learners. 52 undergraduate learners from different ethnic backgrounds (e.g., Caucasian, Asian, African American) were participants of the study in a highly controlled lab setting. The participants were instructed different Basque words with AR-based and flashcard learning materials. The qualitative feedback from the learners revealed that a remarkably large number of participants found the AR headset to be a more enjoyable type of instruction than flashcard instruction.

However, the aforementioned studies present several limitations. First, Solak and Cakir’s (2015) study did not identify the measurement type used in their study. Second, a single comment from the teacher was reported as the finding (He et al., 2014). Finally, Ibrahim et al.’s (2018) study had been conducted in a laboratory context. Admittedly, the claim that lab-based AR interventions can be better implemented than in the classroom context, however, other language researchers should conduct comparative studies in a less controlled environment (Ibrahim et al., 2018).

4. Flow Questionnaire

In technology-mediated learning environments, the concept of flow has been used to analyze the motivation level of learners. Cooper (2010) reviewed studies in technology-mediated learning environments and suggested that many studies have proven the existence of a positive relationship between flow and learning. Webster, Trevino, and Ryan (1993) conceptualizes learners’ reported use of flow on the playfulness of human-computer interactions. Huang, Liu, Wang, Tsai, and Lin (2017) also argued that among many indicators that assess cognitive, behavioral, and affective factors, flow is considered a robust indicator for learner engagement because it shares certain characteristic with engagement such as feedback

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¹ Microsoft HoloLens is a head-mounted display developed and manufactured by Microsoft. The device allows real-time mapping and a deeply immersive mixed reality environment.

14 Young Foreign Language Learners’ Engagement and Motivation in Augmented Reality-based Vocabulary Learning
and intrinsic motivation.

Flow was first introduced by Csikszentmihalyi (1975) and adopted by many researchers in a wide range of areas, including sports, music, marketing, and education, to conceptualize and evaluate the quality of performance (Cho, Wang, & Fesenmaier, 2002; Custodero, 2002; Egbert, 2004; Jackson & Eklund, 2002). Flow can be defined as an optimal psychological state where an individual is “in control of his actions, and in which there is little distinction between self and environment, between stimulus and response, or between past, present and future” (Csikszentmihalyi, 1975, p. 36). A person in a flow state becomes totally engaged in an activity and experiences many positive feelings such as “freedom from self-consciousness, great enjoyment of the process, clarity of goals and knowledge of performance, complete concentration, feelings of control, and sense of being totally in tune with the performance” (Marsh & Jackson, 1999, p. 344). Therefore, learners in a flow state are motivated even when there is no extrinsic reward, similar to second language learners who are intrinsically motivated.

Several researchers have used flow to measure student engagement and motivation level (Admiraal, Huizenga, Akkerman, & Ten Dam, 2011; Bressler & Bodzin, 2013; Inal & Cagiltay, 2007; Park, Parsons, & Ryu, 2010). As Diegmann, Schmidt-Kraepelin, Eynden, and Basten (2015) analyzed in a review study, most educational researchers reported increased motivation for learning as a prominent benefit of AR-based learning material. Ibáñez et al. (2014) recognized that such findings have encouraged AR researchers to further examine the effects of AR on a learner’s flow state (Choi & Baek, 2011; Dalgarno & Lee, 2010; Kye & Kim, 2008; Pearce, Ainley, & Howard, 2005). With regard to vocabulary learning, Hsu (2017) used flow in a comparative study of two different types of AR-based materials: self-directed and task-based. The results indicated that self-directed AR led to greater flow among learners than task-based AR.

Webster, Trevino, and Ryan (1993) identified four dimensions (i.e., control, attention focus, curiosity, internal interest) of the flow state proposed by Csikszentmihalyi (1975) and developed 12 items which could measure flow dimensions in human-computer interactions. Some of the characteristics and benefits of AR-based materials pointed out by previous AR educational researchers are closely related to these four dimensions of flow.

Control

According to Csikszentmihalyi (1975), individuals think that the activity they are doing is playful if they have control over the interactions with computer. Technology-enhanced learning materials can provide learners with control by adapting to feedback from learners. One of the
three characteristics of AR defined by Azuma (1997) is its ability to allow learners to interact in real time. The interaction patterns of AR can lower barriers to use and give learners more control over their learning (Bujak et al., 2013). In addition, AR enables collaborative activity since it combines “face-to-face collaboration with access to virtual learning content” (Bujak et al., 2013, p. 542). Of course, during collaborative activities with multiple people, learners can still have their own individual perspectives on the content.

Attention

An individual in a flow state focuses on a limited stimulus field and rules out irrelevant thoughts and perceptions (Webster et al., 1993). In AR-mediated learning, a handheld device where an AR-based intervention takes place can act as a limited stimulus field. Billinghurst (2002) noted that learners in AR interfaces can be seated around a table and collaborate with others while focusing their attention on a device, while users of desktop interfaces are seated side-by-side, focusing their attention on the screen space. Billinghurst also maintained that AR has the ability to help learners focus their attention. Some AR researchers found that AR-based learning materials were very effective at drawing learners’ attention (Barreira et al., 2012; Di Serio et al., 2013). Specifically, young learners described their experience with AR during learning as magical and showed high levels of attention during learning (Barreira et al., 2012). In a study comparing two types of AR-based learning systems, Hsu (2017) expected that the AR systems “could reduce extraneous cognitive load, making more working memory capacity available, and thus redirecting the students’ attention to the cognitive processes directly relevant to the construction of their knowledge schemas” (p.145).

Curiosity

According to Ciampa (2014), curiosity is the most direct component of intrinsic motivation in education. Malone and Lepper (1987) categorized curiosity into sensory and cognitive curiosity. Sensory curiosity is aroused when there are attention-attracting variations and changes in the environment, while cognitive curiosity is aroused when learners realize the incompleteness of their knowledge and seek to attain new information through exploration. When in a flow state, an individual’s curiosity is enhanced (Malone, 1981). In AR-mediated learning environments, unlike in VR environments where learners are separated from reality, the learner’s reality is transformed. This effect can surprise and stimulate curiosity (Bujak et al., 2013).
Internal interest
An individual in a flow state may find the activity he is engaging in to be intrinsically interesting (Csikszentmihalyi, 1975). Thus, the learner is more likely to be engaged in the learning process for pleasure and enjoyment. AR could integrate meaningful objects with learning content. This familiarity can appeal to students because contextually relevant information can be obtained which satisfies the learner’s interest (Bujak et al., 2013). Solak and Cakir (2015) also stated that the use of pictures, videos, and animations in AR systems provides richer input and makes the learning process interesting.

III. METHOD

1. Research Question
The present experimental study used t-test models to investigate the differences between non-AR- and AR-based instructional groups’ engagement and motivation levels while learning second language vocabulary. In this study, we conceptualized student engagement and motivation as (a) concentration, (b) control, (c) curiosity, and (d) internal interest. In addition to examining the differences in students’ engagement and motivational levels, we also examined their interview responses. We addressed the following research question: What are the effects of an AR-based vocabulary instruction on students’ engagement and motivation levels?

2. Participants
Participants were 38 third-, fourth-, fifth-, and sixth grade students in a metropolitan district located in the northeastern region of the Republic of Korea who were participating in a two-week English camp. There were 20 boys and 19 girls. Of the sample, five students were selected for a focus interview. The participants were randomly assigned to non-AR-based group and AR-based group with 19 students for each group. All students in the AR-based instruction group were asked if they wished to participate in a focus group interview and share what they experienced and how they felt during the treatment with the researcher; two girls and three boys volunteered to be the interview participants. Two of the participants were fifth-grade students from the same class, and the other three were third-grade students from the same class.
Participants were part of a larger study investigating the effects of AR-based instruction on vocabulary performance\(^2\). The dataset used in the current study contains rich descriptors of the effects of AR-based instruction on young L2 learners’ motivational level.

3. Instruments

Instruments used in the current study were a flow questionnaire and a semi-structured interview. The flow questionnaire was used to compare the engagement and motivation levels of non-AR and AR groups during treatment. The semi-structured interview was also used to increase validity using triangulation. Triangulation, as noted by Erzberger and Prein, (1997), refers to a method of integrating multiple data sources to complement and support the interpretations and conclusions in qualitative study. The follow-up questions in the interview revealed details that the flow questionnaire could not elicit.

The flow scale (Webster, Trevino, & Ryan, 1993), mostly used in technology-mediated learning environments (Cooper, 2010), consisted of 12 items that measured the students’ motivational level. This measure has been shown to demonstrate good reliability (Cronbach’s alpha = .82) and has been adopted by several educational technology researchers to analyze how participants are motivated in educational contexts (Wei, Kao, Lu, & Liu, 2018).

Webster et al. (1993) analyzed the four subscales of flow as described by Csikszentmihalyi (1975): concentration, control, curiosity, and inner interest (see Table 1). The same questionnaire was used for non-AR condition except that “Quiver” was replaced by “pictures.” Each subscale consisted of three questions and item responses were rated along a 5-point scale, ranging from 1 (not at all) to 5 (very much). The questions numbered one, two, five, and ten were reverse-scored as in Webster et al. (1993). Overall, the scale employed for the sampled population had a good discrimination index (d-index) ranging from .21 to .79 and an internal consistency estimate (i.e., Cronbach’s \(\alpha\)) of .86. This questionnaire was translated into Korean to help participants understand the question items.

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\(^2\) After the researcher examined the list that is available to teach using the AR-based application, the target words were selected from the list in consultation with the previous coordinator of the camp to increase ecological validity. The 15 target words for the study were: lava, crater, magma chamber, erupt, flow, fire engine, ladder, hose, fire hydrant, spray, firecracker, fuse, cylinder, cone, explode.
## Number of Items per Scale, Item-to-Total Correlations, and Cronbach's Alphas per Item Sets (n=38)

<table>
<thead>
<tr>
<th></th>
<th>k</th>
<th>( \leq ) rit ( \leq )</th>
<th>Cronbach's alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concentration</strong></td>
<td>3</td>
<td>.29 ( \leq ) rit ( \leq ) .55</td>
<td>.53</td>
</tr>
<tr>
<td>1. When using Quiver, I thought about other things.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. When using Quiver, I was aware of distractions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. When using Quiver, I was totally absorbed in what I was doing.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>3</td>
<td>.46 ( \leq ) rit ( \leq ) .69</td>
<td>.72</td>
</tr>
<tr>
<td>4. When using Quiver, I felt in control of what I was doing.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I felt that I had no control over my activity with Quiver.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Quiver allowed me to control the activity.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Curiosity</strong></td>
<td>3</td>
<td>.59 ( \leq ) rit ( \leq ) .77</td>
<td>.83</td>
</tr>
<tr>
<td>7. Using Quiver excited my curiosity.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Quiver made me curious.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Internal interest</strong></td>
<td>3</td>
<td>.56 ( \leq ) rit ( \leq ) .81</td>
<td>.86</td>
</tr>
<tr>
<td>10. Using Quiver bored me.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Using Quiver was interesting.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Quiver was fun for me to use.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sum of subscales</strong></td>
<td>12</td>
<td>.21 ( \leq ) rit ( \leq ) .79</td>
<td>.86</td>
</tr>
</tbody>
</table>

*Note.* rit=corrected item-total correlations

Quiver is the AR application used in the current study.

Focus group interviews complement surveys rather than replacing them (Bernard, 2017). According to Tracy (2013), focus group interviews are used to examine how participants in the same group react to a shared experience. Tracy also maintains that the participants in focus group interviews show less inhibition, especially when they interact with similar people. Focus group semi-structured interview questions were developed to elicit rich information about the reasons for the differences in motivational levels between the two experimental groups (see Appendix). The researcher also asked additional questions which were not in the interview questions such as “Why was it less boring?” and “Why was it easier to memorize the foreign words?” to expand on the data collected from the flow questionnaire.
4. Treatments and Procedures

Learners were randomly assigned to either the non-AR condition \((n = 19)\) or the AR-based condition \((n = 19)\). The non-AR- and AR-based conditions were identical, except that the learning materials for the non-AR-based instruction were picture-based. Among some of the AR-based mobile applications currently available, Quiver was chosen in the study since it contains learning materials that target young learners, and thus the vocabulary in Quiver is appropriate for the participants’ age and proficiency level. The theme was also appropriate for young learners. Three thematic colored pictures (fire truck, firecracker, and volcano) were presented to the learners in small groups and the experimenter described the meanings of the new vocabulary words in the pictures. In the AR condition, these same words were illustrated to groups of two to three students using Quiver. The treatment comprised one 15-minute instructional session.

To accurately compare the motivational levels of the two experimental groups, the flow questionnaire was administered immediately following the treatment to both groups. This session lasted approximately 10 minutes. One week after completing the questionnaire, the focus interviews were administered. The students were given the questions prior to the interview and had one hour to reflect on their experience using the AR-based instructional app. The interview was conducted in a spacious room located next to the participants’ original classroom and was audio-recorded with the consent of the participants. The interview lasted for about 20 minutes.

IV. RESULTS AND DISCUSSION

1. Mean Differences in Engagement and Motivation

Table 2 presents the means and standard deviations for each subscale for each treatment group. An independent samples \(t\)-test was computed in order to examine whether there was a significant difference in engagement and motivation levels between the AR-based and non-AR-based treatment groups. If the differences did not turn out to be statistically significant, this did not mean that the AR-based group had no impact on instruction. Instead it meant that both non-AR- and AR-based instruction influenced second language learners’ motivation levels.
The independent sample $t$-test results for each subscale (i.e., control, internal interest, attention, curiosity) of the flow questionnaire are presented in Table 3. Overall, students’ engagement and motivation level in the AR condition was significantly different from 0 for the subscales of curiosity and internal interest but not for the subscales of control and attention. Specifically, for the internal interest subscale, the mean score of the non-AR group was 2.53, while the mean score of the AR group was 3.28, showing a significant difference between the two groups, $t(36) = -3.06$, $p < .05$. Similarly, for the curiosity subscale, the mean score of the non-AR group was 2.75, while the mean score of the AR group was 3.74, showing a significant difference between the two groups, $t(36) = -2.42$, $p < .05$. These results indicate that the AR-based instruction was more effective as compared to the non-AR-based instruction in motivating students in terms of the internal interest and curiosity subscales.

However, with regard to the control and attention subscales, the non-AR group did not significantly differ from the AR group in the control, $t(36) = -.67$, $p = .508$, or the attention, $t(36) = -1.92$, $p = .062$, subscales. Although both subscales (control, $M = 3.16$, $SD = .59$; attention, $M = 2.35$, $SD = .52$) revealed that second language learners’ control and attention in the AR condition were higher than in the non-AR condition (control, $M = 3.02$, $SD = .70$; attention, $M = 2.04$, $SD = .50$), neither subscales reached statistical significance. This indicates that the effectiveness of the AR-based instruction in motivating students in terms of control and attention were similar with the non-AR-based instruction.
2. Semi–Structured Interview on Student Motivation

To determine how students in the AR group were motivated with the AR-based treatment (and how they perceived it to be different from the traditional instruction they received prior to their participation in the study), a semi-structured interview was administered with five participants in the AR group. The qualitative results yielded additional evidence that the AR-based instruction led to higher motivation in terms of internal interest and curiosity than traditional types of non-AR-based instruction. As shown in Table 4, the most frequent responses from the participants were on internal interest, followed by curiosity, attention, and control.

![Table 3](image)

<table>
<thead>
<tr>
<th>Subscale</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
<th>Mean difference</th>
<th>Std. error difference</th>
<th>95% Confidence interval of the difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-0.67</td>
<td>36</td>
<td>.508</td>
<td>-0.14</td>
<td>0.21</td>
<td>-0.57 - 0.29</td>
</tr>
<tr>
<td>Internal interest</td>
<td>-3.06</td>
<td>36</td>
<td>.004</td>
<td>-0.75</td>
<td>0.25</td>
<td>-1.25 - -0.25</td>
</tr>
<tr>
<td>Attention</td>
<td>-1.93</td>
<td>36</td>
<td>.062</td>
<td>-0.32</td>
<td>0.16</td>
<td>-0.65 - 0.02</td>
</tr>
<tr>
<td>Curiosity</td>
<td>-2.42</td>
<td>36</td>
<td>.021</td>
<td>-0.98</td>
<td>0.41</td>
<td>-1.81 - -0.16</td>
</tr>
</tbody>
</table>

To maintain anonymity, the answers from each participant were labeled with an alias. Excerpt 1 and Excerpt 2 show how participants responded in relation to internal interest subscale.

Excerpt 1. Min Ji’s response to internal interest subscale

*Excerpt 1 and Excerpt 2 show how participants responded in relation to internal interest subscale.*
Teacher: Does anyone volunteer to tell me the difference between how you used to learn the vocabulary and how you learned with Quiver? For example, picture books, videos, and vocabulary lists.

(...)

Min Ji: It was boring when I learned with picture books and other things, but it was not with Quiver.

Excerpt 2. Jung Won’s response to internal interest subscale

Teacher: What else was memorable?
Jung Won, Young Soo: (Raise hand)
Teacher: (Point Jung Won) Okay, you go first.
Jung Won: (...) It was fun.

When students were asked about the most memorable moments during treatment, many students answered that the most eye-catching moments, like when the firecrackers exploded or when the volcano erupted and lava flowed, were the most memorable. When the researcher asked the participants about what made the learning more fun, the three participants answered that it was the three-dimensional presentation of the learning content. Additionally, in response to the open-ended question, “Is there anything you would like to share with us?” one of the participants responded that he tried using Quiver after the treatment with his mom because he thought the experience was fun. Excerpt 3 shows how participants responded in relation to the curiosity subscale.

Excerpt 3. Jung Won’s response to curiosity subscale

Teacher: Does anyone volunteer to tell me the difference between how you used to learn the vocabulary and how you learned with Quiver? For example, picture books, videos, and vocabulary lists.

(...)

Jung Won: (Raise hand)
Teacher: Okay, what would you like to share?
Jung Won: Usually, we learned through vocabulary books and videos. But, you know, kids love electric devices. So, it was fun because it makes kids more curious.

Furthermore, when students were asked to give some suggestions for future learning, they answered that they would like to learn more challenging or longer words using Quiver. They also answered that they would like to explore other themes like space. Excerpt 4 shows how participants responded in relation to attention subscale. Finally, as shown in Table 4, there were no responses related to the control subscale.
Excerpt 4. Min Ho’s response to attention subscale

Teacher: How was studying vocabulary with Quiver? Any volunteers?
Min Ho: (Raise hand)
Teacher: Yes, please tell me.
Min Ho: I could concentrate better since it was three-dimensional.

3. Discussion

The findings of the present study provide partial evidence for the potential of AR-based learning materials to motivate learners, in line with the view of many educational researchers (Bujak et al., 2013; Di Serio et al., 2013; Solak & Cakir, 2015). Among the four subscales that constitute motivation, the AR-based material used in the current study proved to be more effective in motivating learners than the non-AR-based material only in terms of internal interest and curiosity.

The results of the focus group interview were in agreement with the results from the flow questionnaire. When the participants were asked why the AR-based instruction was good and worth using again, their responses were mostly related to curiosity and internal interest. As Bujak et al. (2013) argued, AR can integrate meaningful objects with the learning content and increase learners’ interest. The learners also answered that the learning experience was fun and interesting since the content was presented in three-dimensional space. In addition, the focus group interview also revealed that AR can enhance both sensory and cognitive curiosity. As to sensory curiosity, learners could recall the most attention-attracting moments even one week after treatment. In addition, the participants answered that they wished to learn vocabulary which are more challenging and longer. As Malone and Lepper (1987) suggested, cognitive curiosity is aroused when learners explore their surroundings to attain new information.

The reason for the non-significant differences between the two experimental groups in the attention subscale may be because too much information and context from the environment were presented to learners. Peterson, Axholt, Cooper, and Elliset (2009) call this excessive information visual clutter and noted that visual clutter could make the displayed information harder to interpret. Furthermore, there was no significant difference between the two groups with respect to the control subscale. One possible reason for there not being higher levels of control in the AR group may be due to the fact that the tablet PCs used in the study could not fully support real time interactions. There was a two-to-three-second delay between scanning the pictures and presenting them three-dimensionally on the tablet PCs. Furthermore, in the
focus group interview, students reported that they had a difficult time holding the tablet PCs for long periods of time. Lastly, unlike AR-based materials, non-AR-based materials do not present environmental features with the learning content, and learners can experience complete control over the content (Santos et al., 2016).

It is noteworthy that all the students in the focus group interview answered that they wished to learn vocabulary again using the AR app, Quiver. Specifically, one of the participants in the focus group interview answered in response to an open-ended question that he even asked his mom to download the Quiver application and used Quiver to learn some words at home. Motivation helps learners maintain the use of language skills after the instructional session is over (Gardner, Lalonde, Moorcroft, & Evers, 1987). The findings from the focus group interview imply that AR-based materials are motivating enough to encourage learners to continue learning even when there are no extrinsic rewards. Furthermore, as Tseng and Schmitt (2008) argued, developing a rich vocabulary requires time. Also, language learners in the digital age often feel bored when learning vocabulary (Derakhshan & Khatir, 2015). Therefore, integrating AR technology into teaching vocabulary could be one possible way to motivate students.

V. CONCLUSION

1. Conclusion

The purpose of the current study was to investigate the engagement and motivation underlying flow state during non-AR and AR-based interventions. Specifically, the aim of the study was to shed light on the subscales associated with engagement and motivation for non-AR and AR-based interventions. A quantitative analysis of an experimental dataset as well as a qualitative analysis of interview data for confirmatory purposes were provided. Both types of analyses yielded results that are well aligned with findings from previous research, affording more conclusive findings about the value of AR-based interventions in increasing learners’ engagement and motivation.

While this study provides strong support for the importance of AR-based intervention in positively affecting young language learners’ engagement and motivation, there were several limitations in the study. There were several study limitations. First, the AR materials used in this study were not developed for learning a second or a foreign language. Therefore, the content
and/or context might not have reflected a learning environment that was familiar to the participants. In future research, utilizing AR materials that more closely tailored to learning a second language would better capture the impact of AR-based instruction in language classroom contexts. Second, the current findings were based on data from a single questionnaire. In order to fully capture the dynamics of engagement and motivational levels, it will be important to assess these levels multiple times over the course of learning a second language. In this way, future research can continue to provide important insights into engagement and motivation development during second language learning. Next, while there were sufficient data points for a t-test analysis, future work in u-learning environment would seem to require a larger sample size to cross-validate the findings of the current study. Lastly, there was only one treatment session in the study. Because of this short duration, the participants were susceptible to novelty effects. To minimize the novelty effect, a study with multiple treatments is needed. It would also be meaningful to investigate how students’ motivation changes after multiple AR-based treatments.

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Young Foreign Language Learners' Engagement and Motivation in Augmented Reality-based Vocabulary Learning

APPENDIX

1. Semi-structured Interview Questions

1) How was learning vocabulary using Quiver?

2) Was there any difference between learning vocabulary with Quiver and with the way you used to learn (e.g., pictures, animations, vocabulary list)?

3) What was the most memorable thing when you learned vocabulary with Quiver?
4) Do you want to learn vocabulary with Quiver again?
5) Do you want any changes if you get a chance to learn vocabulary with Quiver?
6) Is there anything you would like to share with us?

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