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Developing Augmented Reality (AR) as Assisted Technology in Reading Based on Content-Language Integrated Learning

Ryani Yulian[1(*)], Ufi Ruhama[2], Sucipto[3]
[1,2,3]Universitas Muhammadiyah Pontianak, Pontianak, Indonesia

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Abstract

Assisted technology has become one of the primary needs for inclusive education, especially language learning. Language learning mediated by technology can provide affordances to English as a Foreign Language (EFL) learners with low English language skills. Therefore, this study sought to design an assisted technology with content-language integrated learning with the ADDIE approach, covering analysis, design, development and implementation to produce meaningful and motivational language learning. The technology and material development results were named assisted technology-enhanced language learning (ATELL) and created with a marker-based augmented reality application. The AR application is an assisted technology for reading comprehension skills that guide the students in critical thinking for critical reading activities. The findings of the study show that students who read with the AR application performed better than with the traditional method. The students also reported a positive perception of the integration of the AR application for language learning for several attributes such as technology interactivity, compatibility, learning ambience, and cognitive condition.

Keywords: Developing Material, Augmented Reality, Reading, EFL Learners

(*) Corresponding Author: ryani.yulian@unmuhpnk.ac.id

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INTRODUCTION

In the digital era, university students as young scholars should possess both hard and soft skills. The advancement of digital technology in learning offers ample innovation in learning models that can bridge students' needs and abilities to the online learning environment. However, the learning approach cannot fully provide exposure to critical thinking and a creative learning environment, especially for students who have difficulties learning a language. Many English as a foreign language (EFL) learners face some hindrances in learning a foreign language because of problems in specific language skills, particularly for Non-English Department students. An inclusive learning model in higher education is critical because universities are essential arenas for young people with disabilities in adult formation and obtaining higher level qualifications that significantly impact future job market opportunities (Riddell & Weedon, 2013).

English for Academic Purposes (EAP) subject is an institutional course in all study programs in Indonesian higher education institutions. EAP subject is commonly taught in the Non-English department in university level as general basic course. In its practice, students with low English input have various obstacles to improving their English skills, especially those with difficulties in reading skills.

Therefore, innovative learning models are needed in the form of multimedia applications as one of the primary needs of the world of education in the 4.0 era. The material development was based on the need analysis on students' critical thinking skills in reading. A sample of 37 students was given a reading test. The descriptive statistics showed that students have a relatively low level of critical thinking ability, with an average value of 12 out of a total maximum score of 24 (Yulian, 2021). This critical thinking ability includes the ability in Bloom Taxonomy (Bloom et al., 2001) includes aspects of remembering and understanding at a moderate level, cognitive aspects of applying and analyzing at a moderate level, and aspects of generating and planning ideas at a low level. Facing the challenges of learning English as a foreign language, especially for low critical thinking skills, interesting learning applications are needed, such as using multimedia elements. Multimedia applications as assistive technology are beneficial for hybrid learning, both remote learning and in the classroom.

The development of innovative learning models in the form of multimedia applications is based on the rapid development of digital technology in the world of education so that multimedia applications can become technology-based adaptive learning media that can be used with devices such as smartphones, laptops, and personal computers. Students will be more enthusiastic about learning by using technology and practical things obtained from various types of multimedia-based digital applications. Multimedia applications integrated into teaching English will provide fun for students, increase enthusiasm in learning English, and optimize a conducive classroom environment for learning English, especially in improving students' language skills (Guan et al., 2018). The multimedia application was developed based on the Content and Language Integrated Learning (CLIL) learning method. This method is a method with a dual focus, namely content and language, that arises because of the role of English as an international language where there is a need in universities for communication needs in the fields of science and professional work (Tzoannopoulou, 2015). Therefore, students who cannot follow the learning objectives through instructional sources, textbooks, or learning materials need special instructional instruction with feedback, instructive corrections, and modified materials using technology-based assistive learning innovations (Rajkumar, 2019).

The multimedia application developed is used to facilitate the learning of English for Academic Purposes (EAP) courses at the Universitas Muhammadiyah Pontianak. The urgency of choosing reading skills is because reading is the main skill that assists the teaching and learning process of English that can be developed for other English language skills. This development is also carried out based on the need to provide teaching materials that can train students' critical thinking skills. The ability to think critically is one of the abilities and the main focus of learning outcomes that students must possess as a standardized requirement in higher education (Halpern, 2001; Wilson, 2016). The vast development of digital technology has enabled educators to utilize various technology applications for language learning. The rapid advancements of technology such as augmented reality and multimedia applications inevitably bring the emersion for language learning (Huang et al., 2021). Augmented reality application creates an opportunity to learn with new ways of learning, interaction, and it potentially increases

motivation in learning with embedded technological learning scenarios (Sampaio & Almeida, 2016). Augmented reality is a completely immersive application mediated by digital information such as images, audio, video and touch covering in a real-time environment; it can be helpful to stimulate all five senses in learning, particularly visual acuity (Kipper, 2013). The combination of digital and visual elements and the environment can lead to a lively and fun activity for the students.

Moreover, the students can easily absorb and recall the information because the learning experience is more engaging. It produces real-time objects in learning and improves the experience to interact with reality (Garzón & Acevedo, 2019; Liono et al., 2021). Augmented reality can provide students with modern multimedia learning experiences where the features can exhibit physical attributes in learning (Chen et al., 2020). The multimodal elements presented by contiguity (on-screen texts, narrative talk, animation, and interactive conversation) can foster meaningful learning in terms of cognitive processing in learning (Mayer & Moreno, 2003). For specific language skills such as reading comprehension skills, augmented reality can foster reading fluency with a model of reading through embedded audio from native English speakers, provide vocabulary enrichment activities, and give independent activities for the students (Howorth et al., 2019).

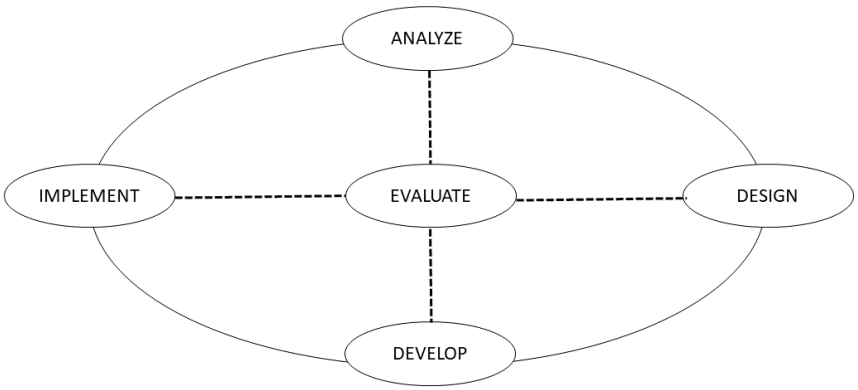
The integration of augmented reality in language learning is a relatively recent advancement. There is a demand to conduct further studies to implement this application in the most directed way continuously. There have been several relevant studies on the implementation of augmented reality in language learning. Bursali & Yilmaz (2019) examined the impact of augmented reality applications on students in secondary school reading comprehension, learning permanency, and attitude towards the application. It was evident that students' reading comprehension skills were improved compared to those who experienced the traditional method of reading. Kaur et al. (2020) investigated augmented reality as interactive learning to enhance engineering education students' motivation. The study reported that the visual effects of the application could enhance students' motivation in the aspects of attention, relevance, confidence, and satisfaction.

To address the gap, this study aimed to design augmented reality-based reading application to the extent that content language integrated learning propels cognitive process of language learners to the prior knowledge of their field of study. The relevance of designing the application is due to the need analysis to provide inclusive technology for language learning. Furthermore, the study did not only develop the assisted technology for language learning but also sought for students' perception in terms of their experiences as the users as it is strengthened by a-state-of-the-art review of 2014-2019 on augmented reality for language learning by Parmaxi & Demetriou (2020) that conclude future research of augmented reality should focus more on the instructional form and user experiences, in this case, the students who engaged in augmented reality especially in reading skills which have little attention in using this technology for language learning.

METHODS

This study used the ADDIE approach, which consists of stages: analysis, design, development, implementation, and evaluation (Branch, 2009). The first

early step was need analysis on the students' ability in critical thinking for critical thinking to map the students' ability. The instrument of assessing students' critical thinking is based on Paul and Elder (2006) practical concepts and tools for critical reading with 6 reading assessment elements, including accuracy, clarity, precision, depth, relevance, and logic. The rubric score for critical thinking in reading ranged from 4 to 1. The scores were analyzed with descriptive statistics. The subsequent phases stick to the instructional design: the ADDIE approach; however, the study did not come to the evaluation stage because of the limited time. The sample of the study consisted of 37 EFL learners of the Non-English Department at Universitas Muhammadiyah Pontianak. The duration of the study, starting from the commencement of data collection to the result dissemination, was from February to October 2021.



Picture 1. The ADDIE Concept ((Branch, 2009)

The first stage is the analysis stage. The analysis stage is the fundamental step in this development to examine where the students are at, including their skills and needs, and give fruitful information on the steps and opportunities to design instructional designs, objectives, and the attainment of goals (Aldoobie, 2015). In this stage, the results of need analysis entailed that most of the students have low critical thinking skills in terms of accuracy, clarity, precision, relevance and logic. The students have high inaccuracy with the wrong idea stated in the reading text. Some of them have low accuracy in terms of stated goals and concepts. For the aspect of clarity, students do not take advantage of facts, data or examples of reading had low precision, attempts to use content-specific vocabulary with minimal use and apparent imprecision. Most students also have a limited understanding of depth in making connections between goals, concepts, and/or supports in reading. On the element of relevance, students have low relevance to the basic conclusions contained in the reading text. Most students have low applicability of context and content to other broad contexts. These findings imply that students have low levels of critical thinking in critical reading with conventional learning. Innovative learning media are needed in multimedia applications with the synergy of Content and Language Integrated Learning.

The second stage is the design. In this stage, the desired performances of the material were verified. This consists of Line-of-Sight by ADDIE, which covers needs, goals, strategies, and assessment (Branch, 2009). The needs were assessed based on the reading rubric by Paul and Elder (2009) to map students' reading skills. The materials were taken from the English for Economics and Business coursebook published by Universitas Muhammadiyah Pontianak with ISBN numbers: 9786027422193. The materials were specifically written to guide reading comprehension activities based on critical thinking skills with the dual focus of English language skills and content of economics, business, and entrepreneurship. The goals were directed in several basic reading comprehension skills such as scanning, skimming, and drawing for the conclusion. This stage was divided into three main phases, namely, the interface design, marker design, and flowchart design. The splash screen of the AR application can be seen in Figure 1.

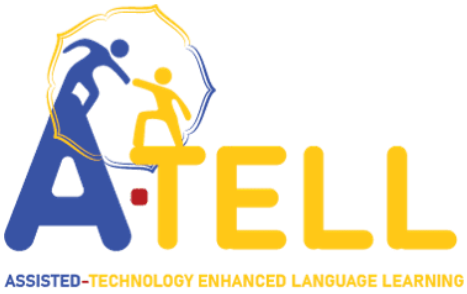


Figure 1. Splash screen of AR application

The third stage is the development stage. It was aimed to develop the augmented reality application with marker-based application guided by AR catalogue. Based on the collected material taken from the coursebook and adapted to the specific instructional objectives of reading comprehension skills, the contents of interface display, 3D object, and marker design with blender 3D and SDK Vuforia application were developed. The next stage is assembly with Unity software as the first system of the implementation of AR application. The designed markers from the catalogue were inserted into Vuforia to produce key points on markers. The conceptual framework of the AR application can be seen in Figure 2.

Figure 2. Conceptual Framework

The fourth stage is the implementation stage. This stage was conducted by trying out the AR application for Non-English Department students majoring in the Economics in one of the private universities in Pontianak with pretest and posttest. The implementation process also sought for students' perception to give an overview of the attributes of AR application for language learning. The implementation of the AR application was carried out through online learning as the nature of this application is to facilitate online learning. Pretest and posttest were employed in the implementation stage in order to measure the significant findings before and after the use of AR application.

RESULTS & DISCUSSION

Results

This study developed augmented reality technology called assisted technology-enhanced language learning (A-TELL) for Non-English Department students majoring in Economics. The topic is social media marketing which aims to provide relevant knowledge of English language skills for the students. Thus, the materials were developed, heeding to Content Language Integrated Learning (CLIL). The learning materials consist of an AR catalogue as this application is a marker-based augmented reality application. The use of marker-based application can be easily operated and it does not require specific and complex application to use it for learning (Buchner et al., 2021). The AR catalogue provides the manual of using the application. This application comprises brainstorming activities for pre-activity, vocabulary enrichment, reading comprehension activities such as scanning, skimming as whilst activity, and drawing for the conclusion as post activity. The initial display of the AR application can be seen in Figure 3.

Figure 3. Initial display of AR application

The initial display of the AR application provides and describes the manual of the application system and to operate the application. All the functions, features, and instructions are presented with step-by-step instructions. The first initial step is

downloading the browser such as Vivaldi and scanning the QR code. The application can be run in android with this browser for each activity provided in the AR catalogue for reading comprehension skills.

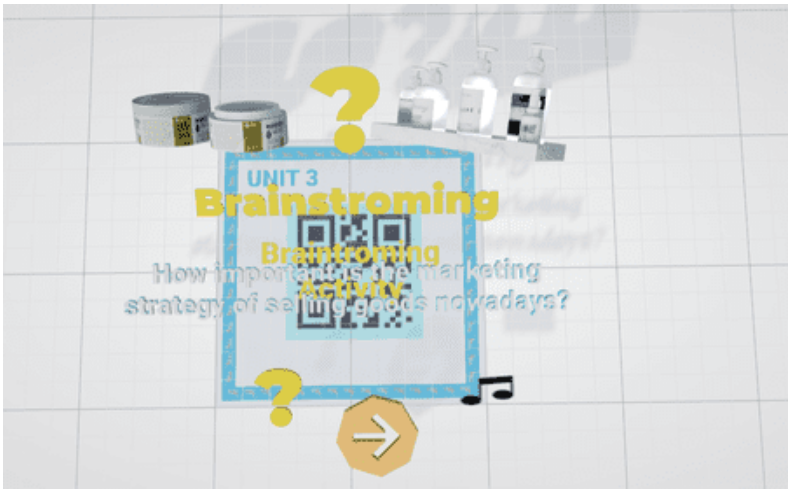


Figure 4. Display of brainstorming activity

As the AR application was used for reading comprehension skills, the students were directed to engage in a brainstorming activity to encourage creative thoughts and stimulate their critical thinking skills. This pre-activity is also used to correlate students' prior knowledge to the current topic. The students were also boosted by the real-time delivery of multimedia elements such as the image of television, smartphone, and laptops to posit some ideas related to the strength and weaknesses of social media marketing as the topic of the material. Initially, the AR application provides brainstorming activity to energize students' prior knowledge of the current issue. It is believed that brainstorming activity can enhance students' motivation and participation, primarily if the content is closely related to prior knowledge (Unin & Bearing, 2016).

Figure 5. Display of brainstorming activity

After the students were situated in a brainstorming activity, they were guided to answer some questions in the scanning activity. Scanning for specific information allows the students to obtain a general overview and find the particular facts regarding the reading passage. An ample of particular facts can enhance more intense details on the current topic of the passage.

Figure 6. Display of scanning activity

Figure 7. Display of scanning activity

The closing activity incorporated postreading activities in the form of a model of expressing opinions such as expressing agreement, expressing partial agreement, and expressing disagreement based on social media marketing. This activity provides visual interaction in model of expressing opinions in order to strenghten the prior knowledge obtain the entire reading activities started from pre-reading activity to the post-reading activity. As reading is a complex-cognitive process that needs combination of phonological codification, multimodal elements, and cognitive responses, so the application provides elements of visual attention to

help the students in multisensory process in reading comprehension skills (Flores-Gallegos et al., 2021).

Figure 8. Display of post-activity

A test with google form was conducted in terms of a pretest and posttest to measure the students' reading comprehension skills. The pretest was conducted in advance before the implementation of the AR application. The posttest was administered directly after the integration of AR application to assess the outcome of students' reading comprehension skills. The assessment test is taken from the coursebook of English for Economics and Business; the topic for the pretest is the characteristics of an entrepreneur, while the topic of the posttest is social media marketing. These topics are derived from content language integrated learning. Both topics provide assessment for reading comprehension skills, such as five questions for scanning for specific information, five questions for skimming for main ideas, and five questions for comprehension in the form of true and false questions. As for pretest implementation, the mean score of students' reading comprehension was 51.4286, with a standard deviation of 6.90066. However, the mean score of the posttest in students' comprehension skills was 81.4286, with a standard deviation of 8.99735. In particular, as shown in Table 1, the posttest score achieved significantly in terms of reading comprehension skills in terms of the AR application in the learning process.

Table 1. Students' pretest and posttest before and after using ATELL

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	7	40.00	60.00	51.4286	6.90066
Posttest	7	70.00	90.00	81.4286	8.99735
Valid N (listwise)	7				

Perception questionnaire was conducted after the implementation of AR application to reveal students' ideas on the attributes of AR application enhanced in

reading contextualized skills. The survey employed a 5-point Likert scale, and all statements were tested as valid and reliable. The first statement shows that students manifested affirmative ideas on the use of AR in terms of easiness (*M = 3,67, SD = 0,82*), students perceived the interaction with the application as clear and understandable (*M = 4,17, SD = 0,41*), and they found it easy to be competent using the application (*M = 3,83, SD = 0,41*). Applying this application requires affordable technology for the students, as they conveyed that they have resources such as a smartphone to utilize AR application (*M = 4,33, SD = 0,52*). Similarly, they posited that they have the knowledge necessary to use augmented reality (*M = 4,17, SD – 0,41*), this technology is compatible with other common technologies used in their learning (*M = 3,5, SD = 0,55*), and they can easily get assistance from others in terms of difficulties in using the application (*M = 3,83, SD = 0,75*). When talking about the learning ambience using the AR application, the majority of the students perceived that AR application is a fun activity (*M = 3,83, SD = 0,75*), they agree this technology can also be exciting (*M = 3,67, SD = 0,53*), and they think that they have control of the augmented reality experience (*M = 3,67, SD = 0,52*). In terms of cognitive condition, majority of the students can bear the nervousness in using the AR application (*M = 2,33, SD = 0,52*) and insecurity (*M = 2,5, SD = 1.05*). Finally, the overall ideas on the implementation of AR application show that majority of students have positive perception to use this application in reading activity as they perceived AR application as credible (*M = 3,83, SD = 0,75*), reliable (*M = 3,5, SD = 0,55*), and trustworthy (*M = 3,83, SD = 0,41*).

Table 2. students' perception of the use of AR application

No	Statement	Mean score	Std. Dev.
1	I think that augmented reality is easy to use.	3,67	0,82
2	I think that my interaction with augmented reality will be clear and understandable.	4,17	0,41
3	It will be easy for me to become skilful at using augmented reality.	3,83	0,41
4	I have the resources necessary to use augmented reality (e.g. smartphones).	4,33	0,52
5	I have the knowledge necessary to use augmented reality.	4,17	0,41
6	Augmented reality is compatible with other technologies I use.	3,5	0,55
7	I can get help from others if I have difficulties using augmented reality.	3,83	0,75
8	Using augmented reality in learning English can be fun.	3,83	0,75
9	Using augmented reality in learning English can be exciting.	3,67	0,53
10	I think that I will feel like I am in control of the augmented reality experience.	3,67	0,52

11	I feel nervous about using augmented reality.	2,33	0,52
12	I feel insecure about my ability to use augmented reality.	2,5	1,05
13	Augmented reality applied to learning English may be credible.	3,83	0,75
14	Augmented reality applied to learning English may be reliable.	3,5	0,55
15	Augmented reality applied to learning English may be trustworthy.	3,83	0,41

Discussion

This study was set up to develop assisted technology for language learning for reading comprehension activity based on students' need analysis of critical thinking for reading. The materials were developed based on content-language integrated learning as this learning method enables dual focus of learning materials which stimulate students' motivation and enthusiasm in learning the language as the content language instruction through English as a foreign language is one of the keys of curricular innovation and the influential individual variables on foreign language learning (Doiz et al., 2014). The EFL learners are students who have low critical thinking skills in readings; thus, they need to have assisted technology that enables them to experience enhanced second language acquisitions. Assisted technology in the form of augmented reality application can be one of the innovative technologies because this technology provides affordances with multimedia and content retention. Recently, the AR application compatibility to language learning is unquestionable because it is easy to adapt the technology with the support of technical devices for the student (Cabero-Almenara et al., 2019). The AR application covers notable affordances of the multimedia elements such as texts, images, audio, and three objects and allows content memory based on the combination of multimedia elements (Karacan & Akoğlu, 2021). When language learning is integrated with the AR application, there is limitless opportunity to classroom windows to gaze the immersions of the topics engaged. It can benefit the students to undergo the real-world connections between the material and their prior knowledge (Bonner & Reinders, 2018).

Developing this assisted technology is also synergized with the empirical data after trying the application to EFL learners. Concerning the quantitative findings of the research, it imparts a conception that augmented reality can be a conducive-provoking application to arouse students' interest to learn English. Bursali & Yilmaz (2019) proved that AR application helped the students obtain higher and permanent scores in the reading activity. A rigorous meta-analysis by Garzón & Acevedo (2019) proved that the majority of the quantitative studies between 2010 and 2018 on augmented reality improved students' achievement and gain in learning. Most reported findings of researches on augmented reality also examined that AR application can promote learning achievement and enhancement scholastically (Akçayır & Akçayır, 2017). Essentially, the convergence of multimedia elements and interfaces to transform an object in real-time and scenario

makes the application attractive and practical and enhance their motivation to learn (Bujak et al., 2013; Bursali & Yilmaz, 2019; Kesim & Ozarslan, 2012). Teaching and learning activities can be more enjoyable because the students are situated by instructors who apply both theories and practices simultaneously (Ismail et al., 2018).

CONCLUSION

The results addressed significant findings that developing assisted technology with content-language integrated learning can be one of the alternatives to mediate the students with interactive and motivational language learning. The study shows that students who engaged in reading comprehension activity with AR application perform better in this particular skill than students mediated by a conventional learning activity. The mean score of the posttest with AR application outperformed the mean score of the pretest significantly. The AR application helps the students interact with the content. At the same time, it provides comprehension enhancement and engagement through the layers of digital contents to the physical world, particularly multimedia elements depicted from the combinations of images, pictures, and audio. In its implementation, the study also posited both empirical and theoretical implications. The empirical data showed that the score of reading comprehension outperformed the score of reading with the conventional method. Still, as this application experiences real-time delivery of material, it is recommended that the students should be exposed and situated the technical assistance in advance before using the application. To mitigate the technical problems, they need to study the manual comprehensively, starting from scanning the barcode code and using the AR application's features. The theoretical implication suggests that the AR application should provide thorough activity reading enrichment to activate the active role in the brainstorming activity and other reading comprehension activities. Some possible suggestions can be attained as the results of the study. This study merely focused on developing reading skills based on critical thinking analysis for critical reading. The technology and material development should be extended to integrated language learning such as reading and speaking.

CONFLICT OF INTEREST

Concerning the research, authorship, and publication of this paper, the author(s) reported no potential conflicts of interest.

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