Effect of an Augmented Reality Tool in Early Student Motivation and Engagement

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1. Introduction

Facilitated learning supports how the students proactively understand and interact with the teacher's motivational guidance. The teachers can apply the facilitated learning model in their classrooms, using a combination of methods and materials, such as reinforcement, class interactions, e-books, and educational games that engage and motivate the students [1]. It can further be described as a way of making teaching and learning interactive and involving for the students, whereby they learn with the support and guide of the teacher using engaging academic tools. The effective implementation of such practices will improve the cognitive learning of the students [2, 3]. Additionally, the facilitated learning engenders the students to discover, innovate and implement solution to problems independently. For the purpose of the study, facilitated learning will be discussed with the use of augmented reality as a tool for learning in a primary classroom.

Augmented reality (AR) is a modern technology that entails the overlaying of audio and visual information on an image target in real time of the user's environment. Alternatively, AR is described as the integration of computer designs, in which visual and audio media information are added onto a real-world scene of the viewer [4]. The theory of augmented reality, as the integration of digital and actual world in real-time, is based on the use of hardware and software identifier tools to identify the image or object of interest and render the computer-generated information on the actual world in real time [5, 6]. This entails the presentation of multimedia information in the real-world using AR technological tools.

Technological literacy, as described by Jenkins [7], is the ability to effectively use technological tools to manage and communicate information. Additionally, Heywood [8] argued that the training of employees directly relates to the quality of the product, which, in turn, results in customer satisfaction. The user-friendly interface of an augmented reality tool can support and improve the technological literacy of students at their early ages. Furthermore, it provides an interactive environment that enhances learning in the user's real world in explaining abstract concepts such as human anatomy, chemical reactions, astronomy, and others for primary classroom students [9]. In relation to the invention and development of AR for various teaching and learning purposes, a relevance is identified for the role of AR in STEM education [10, 11].

Today, the AR technology is still in the evolution stage. This entails the development of AR applications from using highly sophisticated devices such as Microsoft HoloLens, Vuzix Blade, to less complicated goggles for mobile phone devices compatible with AR technology. The purpose of this study is to explore the effectiveness of augmented reality tool as an alternate technological aid in primary school children's learning. The researchers infer that the use of such motivational techniques for learning is not limited to a subject such as English language but is also beneficial to students in studying other related subjects such as basic science, fine art, agricultural science, physical and health education [12].

2. Literature Review

Augmented reality tools have been implemented with the aims of increasing student engagement, spatial cognition, and improving understanding [13, 14]. The researchers developed 3D representations of part models to visualize orthogonal views from the model's perspective orientation. The outcome of the study was promising as the integration of an AR tool in a computer-aided design class provided enhanced improvement of spatial cognition in early engineering students. One of the most common rationales for integrating AR tools in the classroom is that they facilitate experiential learning and support the active learning. In addition to Dakeev et al. [13, 14]'s study, earlier research found that the AR tool promotes tactile learning [15], involves students in engaged participation in class, and encourages self-education and development by providing educational experiences [16, 17] that improve students' cognitive abilities. The learning should be more participatory than merely listening to instructions [18], and it must be both physical and psychological in nature [19] to facilitate an increased level of participation of students' physical and mental abilities [20]. In the definition of experiential learning, Awidi & Paynter [21] integrated "learning through interaction with others" as a development of capacity to apply or transfer one's knowledge and skills to others that deepens understandings." Moreover, AR may improve the enhancing teaching and learning for students to reduce the impact of in-class learning constraints such as learning under limited time [22] as well as serve as a viable tool for engaged learning for students with special needs [23].

This study involves the introduction of an augmented reality tool in primary school students. The researchers, such as Freitas & Campos [24], stated that AR could promote engaged learning, class interaction and better understanding of concepts when used as a learning tool for children. The AR tool can provide physical environment for interaction, actions and resources for the trainers, and response of the learners [25], and develop students' cognitive reasoning abilities [24, 26] in addition to better educational performance and achievement [27].

3. Methodology

This study investigates the effectiveness of an AR tool for promoting engaged learning in technological literacy for STEM education. A total of 42 children (25 female and 17 male) from three different first grade classes, with diverse socio-ethnic backgrounds, participated in the study (Table 1). One of the classes experienced a conventional teaching method by their class teacher, the second class experienced the integration of the AR tool in their learning, and the

third class experienced both methods. In this way, the researchers achieved two groups for study and attempted to achieve a homogenous participation with limited interruptions of the outcomes.

Table 1. Frequency distribution of participant gender

Participant Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	17	40.5	40.5	40.5
	Female	25	59.5	59.5	100
	Total	42	100	100	

The participating students were split into two groups, a control group (standard=24) and experimental group (experimental AR=18), to explore the effectiveness of the AR tool in the learning and engagement of students as shown in Figure 1.

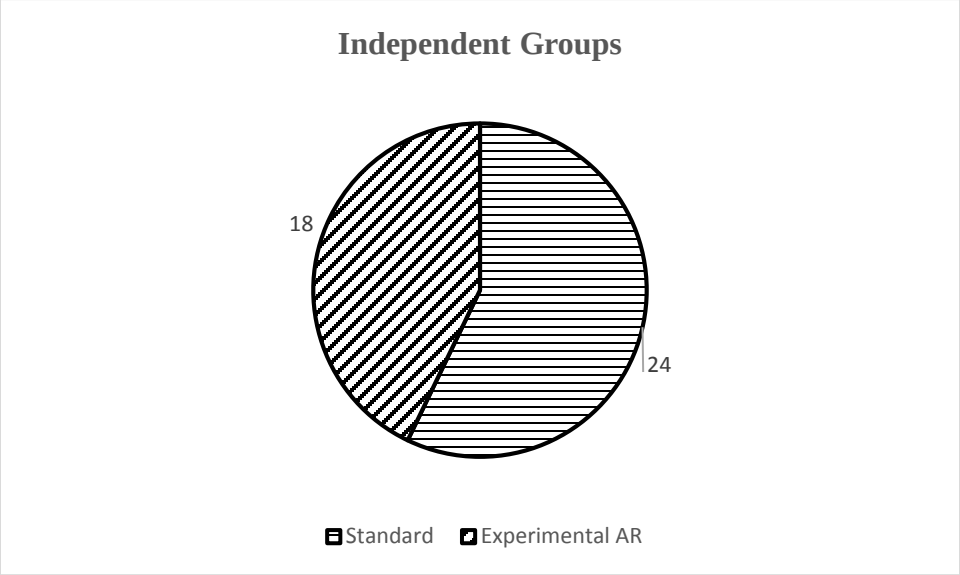

Figure 1. Distribution of standard and experimental AR groups

The creation of the AR tool (Figure 2) for the study entailed the use of different motion graphic and 3D animation software such as Adobe Illustrator for designing the different image targets used, Autodesk 3D's Max and Blender for modeling of the models. The models and image target were integrated using the Unity game engine, to develop the augmented reality tool used for the study. The AR tool is an interactive, visual, free of charge, downloadable app that can be installed any modern smartphone. The app can be installed on both Android and iOS platforms with the supporting resolution of phones and tablets.

Figure 2. Augmented reality tool, 3D representation of objects, with the image target

All three class materials were delivered by their class teachers. The first class received a conventional teaching method that explains maturity levels and color changes of fruits illustrated on the alphabet (Figure 3).

Figure 3. Excerpt of an alphabet used to describe the maturity levels of fruits as well as an image target for the AR Tool

For the conventional method (standard group), the class teacher explained the fruits or vegetables on the provided alphabets and the color change as the maturity progresses. For example, an apple, depending on the type, changes its color from green to red when it is ripe. Similarly, honeydew does not change the color throughout the maturity progress.

The experimental group received only an instruction demo by their class teacher as well as the researchers on how to use the augmented reality tool (Figure 1) with the image target (Figure 3) and analyze the objects' forms and colors at various stages of the maturity level (Figure 4).

Figure 4. First grade students interacting with the AR Tool and analyzing the 3D representation of the image target

The researchers, in accordance with the class teachers, provided the survey tool to collect data for the learning and retention. These data were statistically analyzed to explore the significance of the AR tool in the learning process.

4. Data Analysis

Researchers conducted an independent sample t-test on the response of the students that participated in the study. The control and experimental groups have a total of 24 and 18 participants respectively (Table 1). The descriptive statistics table (Table 2) illustrates that the mean value for the experimental AR group increased by 4.736 points, where the mean value for the standard group was mean 1 = 11.875 and the mean value for the experimental AR group was mean 2 = 16.11.

Table 2. Descriptive statistics for participating groups (standard & experimental AR)

Group Statistics						
Response Participants Score	Participant Groups	N	Mean	Std. Deviation	Std. Error Mean	
	Standard	24	11.875	4.377	0.893	
	Experimental AR	18	16.611	2.524	0.595	

The independent sample t-test (Table 3) showed that there was a significant difference p = 0.001< p = 0.05 alpha level between the two groups. Therefore, the students' involvement and participation in academic learning with the integration of the AR tool improved significantly.

Table 3. Independent sample t-test analysis for the standard and experimental AR groups

Independent Samples Test										
		Equality of Variances		t-test for Equality of Means						
									Interval of the	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Response Participants Score	Equal variances assumed	7.257	0.010	-4.100	40	0.000	-4.736	1.155	-7.071	-2.402
	Equal variances not assumed			-4.412	37.849	0.000	-4.736	1.073	-6.909	-2.563

The success of a student learning is highly dependent on the availability and literacy of experiential technological tools provided to them. The researchers introduced the first-grade teachers to the augmented reality tool used in this study. Once the teachers became well familiar with the application of the AR tool, they provided the demonstrative education to their classes. Overall, the investigators observed that cognitive reasoning [26] and interest in learning improved with the integration of AR tools in the classrooms. Although the first-grade teachers commented that uncertainties of technological devices may hinder the technological literacy in students, the AR and VR tools could benefit the students' retention of the newly introduced material at early ages.

5. Summary and Conclusion

This study has highlighted that the introduction of an augmented reality tool to support the conventional teaching in first-grade students can be beneficial to teachers and instructors because it allows the children to interact with one another and retain the newly learned information better, especially when the students are not in the field trip for a hands-on experiential learning. Based on results from the study, unique distinctions between the two groups and the method of teaching and learning were established. First, there was a significant improvement in student retention of the material (mean 2 = 11.875 > mean 1 = 16.611, p=0.001 with 95% confidence interval). Second, the students who experienced the AR tool were more interactive, talking, discussing, and engaging (researcher observation in the classroom as well as Figure 4). Lastly, the teachers were excited to use the AR tool and implement in other classes with more advanced material to deliver to students.

Although the study revealed the importance of AR technology in improving engaged learning and technological literacy, it is also recommended that the teachers be trained in the operation and use of AR tools for teaching and learning, as they are the first point of contact with the students in classroom activities. Augmented and virtual reality tools can be used as supporting technological equipment to enhance student interaction and engagement as well as reduce the

cost of field trips yet increase the practical learning experiences. The AR and VR tools can improve student interaction with the technology and develop curiosity in STEM fields in the future [27].

6. Future Work

The authors have reported how VR and AR tools had been implemented and their influence in freshman and sophomore engineering graphics classes. However, more study and monitoring are needed to assess to what extent the earlier engagement with technological literacy affects their college careers. Therefore, works are in progress to study the engaged learning and motivation to technological literacy in primary and secondary, as well as freshman-level students, in their successive academic years via AR and VR tools.

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