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Enhancing Students' Interest in STEM-Related Subjects at Omani Post-Basic Schools through Application of Augmented Reality

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Abstract: With the goal of preparing students to be competent employees with a range of abilities, including critical thinking and problem solving, STEM education is a demanding trend. To encourage students to pursue this field of study, there is a need to address the low interest in STEM-related subjects. One of the innovative technologies, augmented reality (AR), has the potential to increase students' interest in studying STEM-related disciplines. It is important to study how this technology could increase students' interest in STEM-related subjects in Oman because the application of the technology is rather new-fangled. This paper presents a proposal to explore students' preparedness and acceptability for an effective implementation of AR technology and how AR triggers, immerses, and extends their interest in studying STEM-related subjects. This study is expected to contribute to knowledge by proposing practical AR application in post-basic schools in Oman.

Keywords: Augmented reality, STEM education, interest

1. Introduction

Countries around the world encounter challenges to create qualified generations contributing to enhance their economy. Therefore, the need for qualified graduates in Science, Technology, Engineering, and Mathematics (STEM) is highly demanding (Atkinson & Mayo, 2010). Research has indicated that STEM education is evolving internationally (Li et al., 2020). This is because governments globally are seeking to fulfil students' shortcomings in terms of practical skills that enable them to be a significant factor in their economy.

In line with the Oman Vision 2040, Oman wants to bring innovation and advanced technologies in its education sector to produce quality graduates (Oman Vision 2040 Committee, 2019). Also, the government emphasizes the importance of studying science subjects – i .e. biology, chemistry and physics and pure mathematics – as elective subjects in grade eleven and twelve. This demands preparing students from early stages. Subsequently, MOE launched the Cambridge International Chains of Science and Mathematics Curriculums in 2017 in government schools.

However, the annual statistics book issued by the Ministry of Education (MOE) in 2019 showed that the number of students who chose science subjects constitutes 33% only of the total number of students in post-basic Omani schools (Ministry of Education, 2019). Furthermore, according to the Trends in International Mathematics and Science Study (TIMSS) 2015, in both grades four and eight, students' interest towards science and mathematics has decreased. Nearly three-quarters of Omani students, and more

than half of the international average of 56%, like learning science in fourth grade. However, the trend is different for grade eight students. Approximately half of Omani students like learning science, compared to the international average of 37% (Ministry of Education, 2018). This reveals that interest in studying science subjects declines gradually with school years (De Lepe et al., 2015; Potvin & Hasni 2014). This explains why maintaining students' interest in studying science is important.

During the emerging technologies era, literature in educational technology suggest that modern technology such as augmented reality (AR) could be effective to enhance students' interest, improve students' success, increase engagement and involve students in activities (Sırakaya & Alsancak Sırakaya, 2020; Wang et al., 2018). However, teachers in Omani schools were reported still using conventional educational technologies such as photos and videos as teaching aids in their classes (Ministry of Education, 2019). The students also seem to show lack of interest in these technologies (Al Rajhi, 2016). With this regard, this study will focus on exploring in what ways AR can be used to enhance Omani students' interest in STEM-related subjects.

2. Literature Review

2.1 The Concept of Augmented Reality (AR)

AR is an emergent technology that has been implemented in different areas in our life. Azuma (1997) supposed that AR is one of the frequently used concepts that allows users to see virtual objects and digital information overlaid on the real world. It is perceived that AR does not replace reality but combines and enhances it. Based on this definition, three features of AR are specified that it integrates physical and virtual, real-time immersive and 3D-registered. Students' perception is not isolated from teachers' perceptions in terms of the use of AR in learning STEM-related subjects. A study conducted by Soo et al. (2019) aimed to determine students and instructors perceptions towards the use of AR revealed positive perceptions by both of them. Students' positive views represented by the interactive characteristics and features of AR. In addition, students became excited as AR technology is novel and interesting. This positive view also was pointed out by Sahin & Yilmaz (2020) in their study that students were pleased about the use of AR in learning science subjects and want to continue using it in the future.

However, in another study, students indicated that they needed more time to use AR and found it a bit uncomfortable in comparison to a conventional lesson (Soo et al., 2019). Research has also indicated controversial views regarding the use of AR from students' perceptions (Akçayır & Akçayır, 2017). In their study, they pointed out that AR to be complicated to implement, while others found it to be beneficial. Therefore, in this case, it would be better to explore the potential of AR in Omani context which will create a clear picture about its uses and accessibility in school contexts and open up a door to stakeholders to take future actions to its implementation.

2.2 Interest Development in learning STEM-related subjects

Interest is viewed by Dewey (1913) as motivating forces underlying meaningful learning that are more powerful than effort alone. In this case, students' persistence does not stand alone in fostering student' learning without interest. He added that it is impossible to separate an interest from an object. This is because interest is considered as a major element in students' learning (Wong et al., 2020) Therefore, interest is a state of mind described by a desire to focus one's concentration on something meaningful to them, such as an activity, a goal, or a subject (Hidi & Renninger, 2006; Regan & DeWitt, 2015). This was ensured Students' interest for STEM-related subjects has a significant impact on whether they persist in their desired stream or convert to an art career trajectory. Sanders (2009) pointed out that, in order to combat the 'STEM pipeline' problem effectively, we ought to discover techniques to involve young learners' interest in STEM education during their school years. Krapp & Prenzel (2011) also emphasized that interest as a prerequisite for science education, as well as a method and goal of science education, remains a significant issue for contemporary academic system.

To develop students' interest in learning STEM-related subjects learning, instructors need to adopt different approaches such as four-phase model of interest development (Hidi & Renninger, 2006), a person-object theory of interest (Krapp, 2002) and flow theory (Csikszentmihalyi, 1990). These approaches and models have been adopted by many scholars to examine the development of students' interest. In this study the researcher will underpin his study by a current theory called Interest-driven Creator Theory (IDC).

2.2.1 Augmented Reality and STEM Education

AR technology contributes in enhancing students' cognitive and affective learning domains in STEMrelated subjects such as science (Yildirim, 2020). Therefore, students are pleased about learning these subjects enabled by AR because of its positive impact that make learning science easy and enjoyable (Sahin & Yilmaz, 2020). AR can increase students' achievement and motivation in learning STEMrelated subjects (Estapa & Nadolny, 2015; Ibáñez et al., 2020; Sirakaya & Cakmak, 2018). It also develops students' thinking (AL-Riyamiah, 2019; Alsakrya & Alsalmy, 2020) and acquiring scientific concepts (AL-Riyamiah, 2019). Because of this significant impact, AR technology is believed could develop different areas in learning STEM-related subjects. Adopting AR in enhancing students' interest in STEM-related subjects is crucial as this technology can promote students' interest in these subjects (Chen & Liu, 2020).

2.3 Developing Students' Interest in STEM-related Subjects Using Augmented Reality

AR is a technology that contributes AR is implemented to enhance students' interest in different subjects and levels. For instance, it plays a significant role in enhancing students' interest in studying STEM-related subjects. Many reasons push students not to be interested in studying science subjects. One of these factors is the abstraction of scientific concepts that makes students put the high requirement to learn and understand them (Swensen, 2016). In this case AR technology can contribute to enhancing students' interest in STEM-related subjects (Bressler & Bodzin, 2013; Goff et al., 2018; Hsu et al., 2017; Ibáñez & Delgado-Kloos, 2018). Research also has indicated that AR enhances students' situational interest (Cai et al., 2014; Chen & Liu, 2020; Chin & Wang, 2020; Zimmerman et al., 2016).

Although there is strong empirical evidence about the impact of AR on students' interest, there is insufficient research about to obtain in-depth insights on the usage of AR in enhancing student' interest in STEM-related subjects. Ibáñez & Delgado-Kloos (2018) emphasized that to obtain a better understanding of how AR technology may enhance STEM learning, it is also a good idea to supplement quantitative measures with qualitative ones. Alalwan et al. (2020) study revealed that students find AR interesting at the beginning however, it maintains students' interest for a short period. Based on that, in-depth insights are needed to identify how AR can trigger students' situational interest and maintain their individual interest. Therefore, the purpose of this study is to explore the potential of AR in enhancing students' interest in STEM-related subjects. In Omani context, a paucity of studies have been conducted to investigate the use of AR in STEM-related subjects. These studies focused on the impact of AR technology on the acquisition of polygons and circle's concepts and spatial reasoning (Alshezawia, 2018) and on the spatial thinking improvement and acquisition of scientific concepts (AL-Riyamyah, 2018). Unlike, this study will focus on exploring its potential in enhancing students' interest in STEM-related subjects based on students' perception.

3. Research Objective

The main objective of the proposed study is to explore the potential of augmented reality in enhancing students' interest in STEM-related subjects at Omani post-basic schools. This will be studied, first by exploring the perceptions of grade ten students in the use of AR technology in learning STEM-related subjects, and second by exploring the potential of AR technology on grade ten students' interest in learning STEM-related subjects.

3.1 Theoretical Framework

This study will use the Interest-Driven Creator (IDC) theory developed by Chan et al. (2018) as the theoretical framework to explore the potential of augmented reality in increasing students' interest in STEM learning in Oman's post-basic schools. The core assumption of IDC theory is that learning experiences enhanced by some type of technology may have a significant influence on increasing student interest. Thus, rather than concentrating on the outcome, the major goal of this theory is to understand how interest is built in learning to arrive at an expected consequence that students would enjoy and strive to acquire (Chan et al., 2018). This theory's design consists of three loops: interest, creation, and habit. In this study the focus will be on the interest loop which consists of three anchors namely triggering, immersing and extending **(Fig. 1)**.

The reason behind adopting the interest loop is in line with the purpose of the study which demands exploring students' interest in STEM-related subjects with the implementation of augmented reality technology. Another rationale is that because AR is a new technology to be incorporated in the Omani setting, it is vital to begin exploring its potential in terms of increasing student interest as a first phase rather than integrating the other two loops of IDC theory, which are the creation and habit loops.

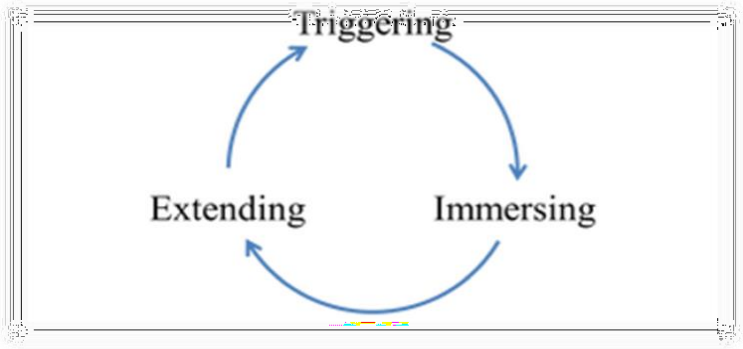

*Figure. 1***:** IDC Theory: Interest and the Interest Loop. [Adopted from Wong et al., 2020]

3.2 Research Questions

As the purpose of this study is to explore the potential of augmented reality technology in enhancing students' interest in learning STEM in post-basic schools in Oman, the following questions are outlined to guide the investigation:

1. How do grade ten students perceive AR technology in learning STEM-related subjects?
2. How does AR technology enhance grade ten students' interest in learning STEM-related subjects?

4. Research Methodology

To answer the aforesaid research questions, this study will employ a qualitative approach which is represented by a case study design encompasses on studying a case in a real and contemporary environment (Yin, 2018). An instrumental case study design type will be adopted to explore the phenomenon. This type is adopted as the case is becoming an instrument for greater understanding something else (Creswell & Poth, 2018; Fraenkel et al., 2012; Mills et al., 2012; Stake, 1995). The case is considered as a vehicle to better understand the issue (Stake, 1995). This means that the broader purpose is not to study the case itself, but to explain how AR implementation enhances students' interest to obtain an ultimate interpretation that demonstrates the phenomenon. Both observation and focus group discussion protocols will be used deductively and inductively in order to answer the research questions.

4.1 Research Setting and Participants

This study will be applied in post-basic schools that apply STEM education in Oman. These schools include grades from nine to twelve and they will be chosen purposefully. The selection of the schools will rely on particular criteria such as the adoption of AR technology by STEM-related subjects' teachers. A number of grade ten students from these schools will be selected to participate in the study. Each class consists of at least 35 students who their ages ranges between 15 to16 years old. The participants will be selected purposively based on specific criteria – i.e. taught by STEM-related subject teachers that adopt AR in their teaching, able to express their opinions eloquently.

4.2 Data Collection Methods and Procedures

Observations and focus group discussion (FGD) will be employed to collect data. Teaching Dimensions Observation Protocol (TDOP) and a self-developed observational protocol will be used during classroom visits to offer descriptive information. A semi-structured protocol also will be developed to guide the FGD. In term of the procedure, firstly, the researcher will observe students from several grade ten classes in multi-sites schools and then, selected students from the observation will be interviewed.

4.3 Data Analysis Methods

Data emerged from observations and focus group interviews will be transcribed and organised by using a computer-assisted qualitative data analysis software ATLAS.ti. After organizing the data, they will be analyzed thematically. To ensure the trustworthiness, triangulation, member check and audit trial strategies will be employed (Merriam & Tisdell, 2016). As this research is conducted to fulfil the first author's PhD requirement in Universiti Putra Malaysia and data will be collected in Oman, the research has sought ethical approvals from Ethics Committee for Research Involving Human Subjects of the university and the Ministry of education (MOE) in Oman. Students' consents will be obtained before they participate in the study to avoid any other ethical issues that might harm them such as deception and to respect their rights (Gray, 2014).

5. Proposed Contribution

This study aids to address STEM-related subjects' teachers to explore the potential of augmented reality in enhancing their students' interests in studying STEM-related subjects. The findings of the study will be beneficial for the teachers to assist them to be attentive to AR affordances that will make the learning STEM-related subjects interesting Furthermore, this will guide them how to to design and implement better teaching and learning using AR in teaching STEM-related subjects. This study will also contribute to the policy makers in making decisions to set a strategic action plan to implement AR in teaching STEM-related subjects. Additionally, curriculum designers will recognize the sorts and quality of activities that need to be included in textbooks so that instructors may utilize them to pique students' interest in STEM-related subjects.

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