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COMPARISON OF AUGMENTED REALITY AND CONVENTIONAL TEACHING ON SPECIAL NEEDS STUDENTS' ATTITUDES TOWARDS SCIENCE AND THEIR LEARNING OUTCOMES

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Abstract. *This study examined the impact of the Augmented reality (AR) use on Jordanian 6th grade students' attitudes towards science and their learning outcomes. A quantitative quasi-experimental study is preceded with the Pre-test and Post-test control group design model, where 24 students who identified to have special needs participated in this study and were randomly divided into two groups. Two groups, control group 12 students were taught conventionally, and 12 students were designated as the experimental group, they used the AR technology for four weeks. The two scales used in this research were reliable and validated. The results show significant results for the AR technology in enhancing student learning outcomes. Additionally, results supported that AR technology has the potential to enhance students with learning disabilities positive attitudes. The result shows that AR technology helped students in promoting positive attitudes towards students and enhance students learning outcomes.*

Keywords: *augmented reality, attitudes towards science, learning disabilities, learning outcomes*

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Introduction

The study of Science is a process that involves several complexities relating to problem identification, problem investigation, hypotheses formulation, data collection method planning, hypotheses testing, data collection, obtaining results and making conclusions (Meerah, 1998; Saidin et al., 2015). Literature highlighted that there is a decrease in science achievement among students (Bicer & Lee, 2019). In other related studies, abstract and ambiguous course contents lead to misunderstanding and low achievement levels among students (Erbas & Demirer, 2019). In the modern educational system, 3.5% of the students were evidenced to display reading problems, which constitute one of the top common and current learning disabilities displayed among them (Karamanoli & Tsinakos, 2015). Additionally, among disabled students, creative interactive activities, visual presentations, project-based learning, and school experiments that are centered on engagement and activities of students are of significant benefit (Obradovic et al., 2015). In this regard, there is a need to stimulate learning disabilities through the use of visual and perceptive activities (Rega & Mennitto, 2017), with literature evidencing that school students are slowly losing their interest and motivation towards learning science subjects (e.g., Cimer, 2012; Potvin & Hasni, 2014). In the face of the tireless efforts made by the educational systems around the globe in supporting special needs students, challenges still abound when it comes to their learning, which are related to the teaching approach, services provided, teachers with lack of experience with the students and identification of students suffering from learning disabilities (Alnahdi et al., 2019; Binmahfooz, 2019). As students with learning disabilities move from one stage to the next, academic requirements and expectations also increase. This is particularly true because evidence shows that learning disabilities have divergent characteristics (Billingsley et al., 2018), while more has to be researched on instructional practices enhancing learning outcomes, achievement and level of engagement of students with learning disabilities (Billingsley et al., 2018).

Therefore, promoting positive attitudes towards science courses among students is a crucial goal among academicians (Musalamani et al., 2021;

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Toma et al., 2019). Among educators, there is an increasing trend to develop and implement evidence-based practice in the hopes of preparation individuals with and without learning disability to live normal, productive, and enriching lives, through refining methodologies refinement and creation (Kellems et al., 2020). Regardless of the countless approaches to teaching, which have been adopted to enhance learning among students with and without disabilities in science courses, authors on the topic indicate inconclusive findings as to the effectiveness of intervention (Kellems et al., 2020; Savelsbergh et al., 2016). The education innovation literature brings forward advance technology as an innovation that could enhance learning outcomes and successful achievements of students in both groups (with and without learning disabilities) (Kellems et al., 2019; Savelsbergh et al., 2016). Advancements in technology have extended the limitations of teaching and learning activities and the development of methods to deliver new courses (e.g., e-learning, virtual lectures, and augmented reality (AR) (Kellems et al., 2019; Khan et al., 2019; Savelsbergh et al., 2016; Yot-Dominguez & Marcelo, 2017). Specifically, augmented reality (AR) has been deemed as a promising innovation that paves the way for teaching and learning opportunities, enhances students' success, those with and without disabilities (Kellems et al., 2019), and it is presently transforming the interaction and engagement of people with inanimate objects (Weng et al., 2020). On the basis of research studies dedicated to the AR technology, AR can promote teaching and learning outcomes in light of achievement, attitude, confidence, motivation, interest, spatial ability, engagement and ultimately, satisfaction of students (e.g., Akcayir & Akcayir, 2017; Weng et al., 2020). The AR technology application has been generally found to enhance experiences in distinct learning environments offering learning activities (Yuen et al., 2011). Augmented reality (AR) covers an extensive range of technology projecting computer generated contents (text, images, and videos) onto real world perceptions (Yuen et al., 2011). In AR technology, a combination of the physical and virtual world is directed towards improving the environment of the user, supported by additional information in the form of camera-generated images, videos and audio through the use of computer and mobile technologies (Sommerauer & Muller, 2014). Yuen et al. (2011) presented a detailed explanation and discussion concerning AR technology and the related applications. In other studies, Akcayir et al. (2016) contended that AR technology application in the field of education has become even more feasible in the current times with new applications facilitated through computers and mobile devices making them affordable, compared to their predecessors that needed sophisticated equipment (e.g., head-mounted displays).

Through the combination of real and virtual objects, AR enables the visualization of abstract concepts and complex spatial relationships and the experiencing of phenomena in a way that cannot be experienced in the real world, and thus, reinforcing the interested towards education (Wu et al., 2013). There are several forms of AR applications like AR books, AR gaming, discovery-based learning, object modeling, skills training (Yuen et al., 2011). In AR books, the digital content is combined with physical contents through the physical book's augmentation with 3D objects, voice and elements of multimedia, enabling the mitigation of gap between the virtual and physical realm (Yuen et al., 2011). Furthermore, AR books facilitate immersive learning, in-depth understanding and encourages the motivation, participation, and engagement of learners (Chen, 2006; Shelton & Hedley, 2002). In the teaching of science such as biology, effective use of visualization methods like 3D materials, actual real-life objects, videos and other technology assist the learners to learn the abstract and invisible concepts of the subject (Cimer, 2012). AR can also be combined, with assistive or instruction technology, according to which the principles of learning design enable students with learning abilities to effectively and successfully learn (Walker et al., 2017).

In this regard, several works have explored AR technology and reported that it affects learning environment (Akcayir et al., 2016; Kellems et al., 2020). In Mc Mahon et al.'s (2016) study, the authors worked with postsecondary students suffering from intellectual disabilities, with the use of AR to instruct them on the vocabulary of science, whereas Chang et al. (2013) used AR with students with disabilities to teach them work-related skills. Chen Lee, and Lin (2015) also used the same to illustrate ways of identifying emotions, and Kellems et al. (2020) involved middle school students in their use of AR to teach mathematics. Despite the adopted teaching approaches directed towards enhancing learning achievements among students (with and without learning disabilities), works dedicated to examining students' outcomes through the use of AR technology are still few and far between, with reported inconclusive findings with regards to the effectiveness of intervention (Kellems et al., 2020; Savelsbergh et al., 2016). Prior studies have only begun to touch the potential of AR as an instructional technique, specifically with those having intellectual disabilities and as such, studies are required to examine its effectiveness when used with SLD students (Kellems et al., 2020). Furthermore, the limited studies of AR studies in light of student attitudes should be noted. According to prior studies (Kellems et al., 2020; Rega & Mennitto, 2017; Walker et al., 2017), research studies dedicated to AR as an evidenced-based approach for instructing students with special

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needs are still few and far between, and as such, the present study primarily aims to examine the viability and feasibility of using AR in textbook design for basic science in an attempt to enhance learning outcomes and to determine attitude towards basic science among students with learning disability. Hence, the present study contributes to literature on knowledge-based interventions, providing positive learning outcomes, as it examines the attitudes of students with learning disabilities towards basic science course, using AR approach, which is the first of this endeavor. This is significant as attitudes play a key role in successful integration of AR technologies in educational settings. This study sought to answer the following research question" how AR application promotes positive attitudes towards science and enhances the learning outcomes among special need students." This study hypothesized no significant differences in students' attitudes towards science and their learning outcomes between AR and the control group.

Augmented Reality (AR) in the Learning Environment

AR studies point towards its high significance in the 21st century for learners with disabilities (Kellems et al., 2020), with related technology enabling teachers to succeed in satisfying the requirements of students with disabilities by allowing them to experience the real world combined with the virtual one, all the while linking it with reality (Karamanoli & Tsinakos, 2017). Nevertheless, research focused on the use of AR interventions for students with disabilities has yet to be extensively conducted as evidenced by the recommendations of Gupta et al. (2019) and Kellems et al. (2020). Among the studies that examined intellectually challenged elementary students using AR for teaching fundamental matching skills successfully was carried out by Richard et al. (2007), while Smith et al. (2016) used AR to examine teaching navigation skills to students with the same disabilities.

In Mc Mahon et al.'s (2016) study, the authors worked with postsecondary students suffering from intellectual disabilities, with the use of AR to instruct them on the vocabulary of science, whereas Chang et al. (2013) used AR with students with disabilities to teach them work-related skills. Chen Lee, and Lin (2015) also used the same to illustrate ways of identifying emotions, and Kellems et al. (2020) involved middle school students in their use of AR to teach mathematics. Prior studies have only begun to touch the potential of AR as an instructional technique, specifically with those having intellectual disabilities and as such, studies are required to examine its effectiveness when used with SLD students (Kellems et al., 2020).

Based on prior studies, AR technology is capable of enhancing educational outcomes and achievements (e.g., Chiu et al., 2015). To begin with, Dede (2009) revealed the relevance of AR in students' engagement in explorations of the actual physical world and Klopfer and Squire (2008) evidenced it enabling the experience of scientific experiments like chemical reactions that cannot be easily experienced in the actual world. In the same way, AR was also evidenced to enable the visualization of concepts like airflow/magnetic fields, and events through the display of virtual elements over actual objects (Dunleavy et al., 2009; Wu et al., 2013).

Added to the above, Singh et al. (2015) showed that AR enhances the students' knowledge and skills and revives their educational interest, and this according to El-Sayed et al. (2011) is true more so compared to other technologies. AR boosts the motivation of the students, their gaining of optimum skills of investigation and steers clear of providing them conceptual fallacies experience (Sotiriou & Bogner, 2008). AR is unique in its visualization features (Erbas & Demirer, 2019) and it has been, time and again, proven to be an effective technology to visualize and provide concrete instances of abstract concepts (Erbas & Demirer, 2019). In the same way, Ab-Aziz et al. (2012) focused on the effectiveness of two technological trends on the learning of students in the special education classes of Malaysia and found augmented reality to benefit their process of learning. According to them, AR does provide advantages to the learning process. Moreover, AR, as a hand phone app was revealed by McMahon et al. (2016) to assist in learning science vocabulary and enhanced general vocabulary among students with disabilities. This was supported in Lin et al.'s (2016) study, who revealed that the app use among students with ADHA and reading disabilities enhanced their word recognition skills. Lastly, Almutairi and Al-Megren (2017) developed an app with AR for the teaching of Arabic to deaf primary school children. They combined video, images and audio with AR and found that teachers and parents of deaf children made effective use of many resources.

Attitudes refer to the response of individuals towards objects and conditions, generating, driving and impacting situations (Inceoglu, 1985). Attitudes refer to tendencies rather than behaviors that direct individuals to behave in specific ways (Sirakaya & Cakmak, 2018). In the context of technology, positive attitudes towards

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it directly affect its use. The attitudes of individuals towards new technology adoption differ and because of such difference, the process of integration may culminate in adoption/rejection of technologies (Akca & Ozer, 2012). According to Sirakaya and Cakmak (2018), the attitudes of students towards new technology will affect its use (effectiveness and productivity) in the classroom and hence, it becomes a must to identify the attitudes of students towards AR applications to ensure its successful use in learning. In effect, attitude towards AR is significant in making sure that it is acquired and disseminated in schools. AR is generally utilized in the education setting to positively motivate students and teachers (Sumadio & Awang, 2010) and to increase the learning experience excitement (Ab-Aziz et al., 2012). It assists abnormal kids to obtain and develop cognitive and motor skills, making education excited, fun, interactive and compelling (Dhamdhere et al., 2019). Finally, prior studies (Kellems et al., 2020; Rega & Mennitto, 2017; Walker et al., 2017), dedicated to AR as an evidenced-based approach for instructing students suffering from learning disabilities are still few and far between, and as such, the present study primarily aims to examine the viability and feasibility of using AR in textbook design for basic science in an attempt to enhance learning outcomes and to determine attitude towards basic science among students with learning disabilities. This main aim is achieved by determining the following research questions;

1. What is the attitude of students with learning disabilities towards AR application?
2. What is the effect of using AR in basic science course on the learning outcomes of disabled students?
3. Do the students who learn using AR learning approach have significantly better attitude towards learning basic science compared to those using traditional learning approach?
4. Do students in the experimental group score higher attitude scores in the pre-test compared to post-test?
5. Do students in the experimental group score higher learning outcomes in the pre-test compared to post-test?

Research Methodology

General Background

This research employed a quantitative quasi-experimental approach with equivalent control group pretest and posttest design (Creswell, 2014), to explore the AR effectiveness in promoting positive attitudes towards science and enhancing the learning outcomes among 6th grade special needs students. The students were selected from the schools following Jordanian Ministry of Education (MoE). The survey was used as it has been generally used to determine characteristics like views, abilities, beliefs, attitudes, expectations, and thoughts (Jdaitawi, 2020; Creswell, 2012; Fraenkel & Waleen, 2006; Sirakaya & Cakmak, 2018; Jdaitawi, 2020). According to Buyukozturk et al. (2008), survey studies primarily aim to present the case under study. The study group consisted of 24 grade 6th students in primary schools that have special needs to examine AR supported instructional experience. The students in the group were identified using purposive sampling method, where the sample is determined on the basis of the research purpose (Fraenkel & Wallen, 2006). This research used the criterion of experience in AR supported instruction to determine the study group. The instruction was provided in a span of 4 weeks divided into 4 units according to the 6th grade science curriculum of the academic year 2018/2019, using AR application. The students were categorized into two groups (AR groups and Control group).

Research Setting and Sampling

In this research, schools having students with special needs were selected in the middle government schools in the Middle governorates of Jordan. It made up of a mixture of different needs. 6th grade students were selected from several schools and were randomly assigned as the research sample. Afterword, two groups with 24 students were selected. 12 students were selected as the experimental group taught using the AR application to learn science, and the other 12 students taught using the conventional approach without AR. Thus, a total of 24 6th graders, aged 12-13, took part in this research as they were accessible and available to the researcher, as well as only 24 students were identified by the schools as special needs students. The sample is tabulated in Table 1 below. The study followed the guidelines and ethical principles stipulated by Jordanian Ministry of Higher Education & Scientific Research. Necessary permission was obtained from the schools where the research was conducted. Furthermore, the researcher informed the participants that the data will be used for the research purpose only.

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Table 1
Descriptive Statistic of the Participants

Characteristic		*N*	%
Group	AR group	12	50
	Control	12	50

Research Instruments

This research used learning outcomes test and Augmented Reality Applications Attitude Scale on primary school students to collect data. With regards to Augmented Reality Application Attitude Scale, it was adopted from the study by Kucuk et al. (2014) to determine the students' attitudes towards AR application in their learning process, with 15 items categorized into three factors, each containing items. Prior studies used the scale and confirmed its reliability and validity (Kucuk et al., 2014). The scale measuring attitude contains three factors, namely satisfaction from use, anxiety to use and willingness to use, and they were measured using 15 items along a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Moving on to learning outcomes scale, the scale was adopted and developed based on several studies, namely Astuti et al. (2019) study, Di-Serio et al. (2013), and Mundy, Hernandez and Green's (2019) study. This scale was used to identify the knowledge levels of students with learning disabilities and their cognitive and effective outcomes relating to the process of learning. There were 11 items measured on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Validity and Reliability

The original version of research instruments was developed in English, since students who participated in this research are native language being Arabic, the instruments were translated and validated translators for Arabic speaking students. However, the instruments were translated by two bilingual speakers who are specialists and a PhD holder. The translated version was given to 5 educational experts for instrument validations, most of them working at the university and some with special needs students. The experts highlighted some issues, and their feedbacks were accepted and incorporated and were corrected accordingly. The scale's internal consistency reliability was found to be .81, indicating that it is a valid and reliable scale used to assess the attitudes among primary school students with learning disabilities towards the use of AR applications. The calculated internal consistency reliability coefficient of the scale was revealed to be .73, indicating its validity and reliability in assessing primary school students with learning disabilities towards AR applications usage.

AR Learning Material

Students' attitudes towards AR applications in educational environments were determined by providing them with the experience in a span of 4 weeks through 8 lessons in 6th grade, with the aim of providing students and teachers with 3D displays of science lessons using school lab. AR application was developed by taking the acquisitions an activity of the "Space" unit included in the 6th grade science class, based on the activities in the textbook. Initially, in this study, the research obtained the opinions and feedback of 2 field experts, 2 teachers and 3 technical experts during the process of the AR application development. The study conducted pre-test and post-test evaluation. There were 24 students with disabilities at the schools. In a ten-minute pre-test organized in the first day, students were given a question to answer without access to any information material or reference classes. Next, they were given the questionnaire related to the study variables. Then, the students were split into two groups. The first group was a control group and the teacher taught them using traditional method, which began by explaining the main ideas and supportive activities and ending by assigning assignment and discussion. The second group was exposed to AR classes in their learning activity. The AR classes were introduced into several lessons in science curriculum. The introduction lesson involved assistant from the teacher as a moderator to demonstrate the activity to students and detailing their difficulties in the subject's context in the form of a visual. Then the students would

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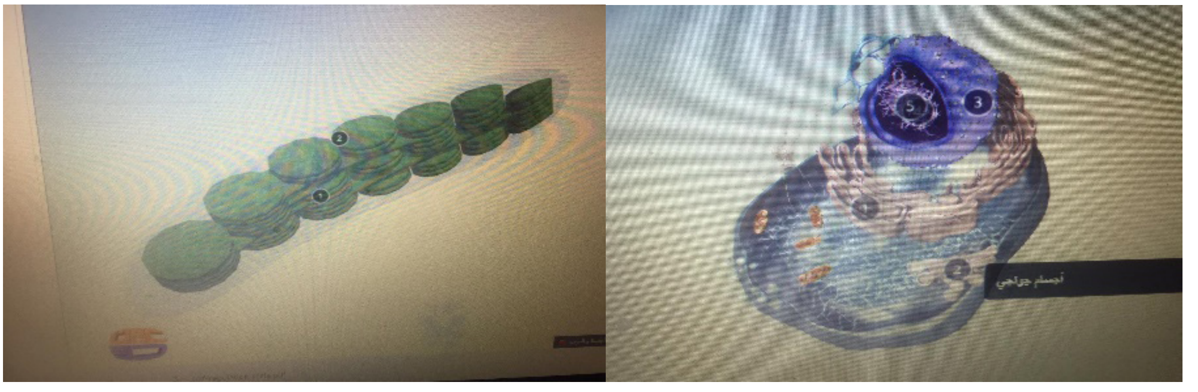
have to repeat the activity without assistance. Then the teacher introduced AR activity to make the topic easier. For each task, participants were accompanied by after the learning activities, the post-test questionnaires were distributed to students for completion. Experimental groups were taught using AR application. Figure 1 showed the activities performed in the AR application.

Figure 1
The AR Activity used in the Study



Data Collection

This research used learning outcomes test and augmented reality applications attitude Scale on primary school students to collect data. With regards to augmented reality application attitude scale, it was adopted from the study by Kucuk et al. (2014) to determine the students' attitudes towards AR application in their learning process, with 15 items categorized into three factors, each containing items. Prior studies used the scale and confirmed its reliability and validity (Kucuk et al., 2014). The scale measuring attitude contains three factors, namely satisfaction from use, anxiety to use and willingness to use, and they were measured using 15 items along a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The scale's internal consistency reliability was found to be 0.81, indicating that it is a valid and reliable scale used to assess the attitudes among primary school students with learning disabilities towards the use of AR applications.

Moving on to learning outcomes scale, the scale was adopted and developed based on several studies, namely Astuti et al. (2019) study, Di-Serio et al. (2013) study, and Mundy, Hernandez and Green's (2019) study. This scale was used to identify the knowledge levels of students with learning disabilities and their cognitive and effective outcomes relating to the process of learning. There were 11 items measured on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The calculated internal consistency reliability coefficient of the scale was revealed to be .73, indicating its validity and reliability in assessing primary school students with learning disabilities towards AR applications usage.

Data Analysis

The data was examined for checking the normality (Skewness and Kurtosis and outlier Mahalanobis) cases using several indicators such as (Judd et al., 2017; Tabachnick & Fidell, 2007). However, the results proved to be normal and outlier cases were identified. Descriptive statistics such as mean *M* and standard deviation *SD* and other statistical tests such as independent sample *t*-test, ANOVA and ANCOVA were involved in this study to identify the possible mean differences between the AR group and control group.

Research Results

Prior to testing the hypotheses (there is no significant difference in the learning outcomes posttest in science course between AR group and control group), the independent sample T-tests were conducted on the independent samples to identify the statistical equivalence of the groups. The dependent variables included are

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learning outcomes and attitudes towards science. In the initial set of statistical tests, the difference between the experimental and control groups in pre-test learning was obtained based on the level of significance (.05). From the result, insignificant differences in t-test were found between the groups based on pre-test of learning outcome scores (F = .003, p = .955, t = .543, p = .599), but F-test for the equal variance was significant. The mean score of the total pre-test sample of learning outcomes is (M = 2.60), with standard deviation of (SD = 0.307). In order to control the significant differences between the groups in the pretest result, ANCOVA analysis was conducted. The analysis was run for the variable learning outcomes of the groups and for the first set of analysis, significant main effects were found for student groups with the dependent variable; for the experimental group the mean square was (value = 3.514, F =17.840, p = .0001 <.05) as shown in table 3. The experimental group showed higher scores for total learning outcomes with a (M = 3.63, SD = 0.481), compared to its controlled counterpart that had a mean of (M = 2.87, SD = 0.380) as shown on table 4.

Table 2
Summary Statistics for Learning Outcomes Variable Pre-test Scores

Variable		Experimental	Control	Total
Learning Outcomes	*M*	2.63	2.56	2.60
	SD	.300	.324	.307

Table 3
Results of ANCOVA for Between-Subjects Effect of the Learning Outcomes Post-test

Source	*MS*	*df*	*F*	p
Corrected Model	1.758	2	8.928	.002
Intercept	3.124	1	15.863	.001
Group	3.514	1	17.840	.001
Learning Outcomes Pretest	.004	1	.020	.889
Error	4.136	21		
Total	261.744	24		
Corrected Model	7.653	23		

p<.05

Table 4
Summary Statistics for Learning Outcomes Variable Post-test Scores

Variable		Experimental	Control	Total
Learning Outcomes	*M*	3.63	2.87	3.25
	SD	.481	.380	.576

To determine the statistical equivalence of the groups in the second hypothesis (there is no significant difference in the students' attitudes post-test towards science course between AR group and control group), the independent samples were exposed to independent sample t-test prior to hypotheses testing. In the first statistical test, the difference between experimental and control groups based on their pre-test attitudes towards science was identified based on .01 level of significance. The t-test results supported insignificant differences between the groups (F = .906, p .351, t = 1.227, p=.233). The post-test scores of the two groups in terms of attitudes towards science indicated significant differences, with the following result for the experimental group ($F = 3.159$, p = .089, t = 2.372, p = .027 < .05) as shown in table 5. The mean score of attitudes in the control group (M = 2.78, SD =0.527) is relative to the experimental group (M = 3.20, SD = 0.304) as presented in table 6.

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Table 5
Results of Independent Sample t-test for Variables Attitudes towards Science Post-test

Variable	*F-value*	*Sig. value*	*t*	*df*	*p*
Attitudes towards Science	3.159	.089	2.372	22	.027

Table 6
Summary Statistics for Attitudes towards Science Variable Post-test Scores

Variable		Experimental	Control
Attitudes towards Science	*M*	3.20	2.78
	SD	0.304	0.527

Based on the results of the ANOVA test, significant differences existed between the groups in light of their attitudes towards science. ANOVA results showed the experimental group to obtain the following values (MS = 1.042, F = 5.626, p = .027 < .05).

Table 7
Results of ANOVA for the Effect of the Attitudes towards Science Post-test

Source	Sum of Squares	Mean *df*	Square	*F*	*p*
Between Group	1.042	1	1.042	5.626	.027
Within Group	4.074	22	.185		
Total	5.115	23			

$p < .05$

Moving on with testing of the test difference hypothesis (i.e., there is no significant difference in the level of pre-test and post-test attitude scores among experimental groups), the study carried out paired sample t-test to determine whether there is a significant mean score of the students with special needs attitudes in the pre-test and post-test scores. The overall attitude in pre-test mean score was found to be (M = 2.45), with standard deviation of (SD = 0.459), while the overall attitude in post-test mean score was (M = 2.99), with standard deviation of (SD = 0.471) as shown in table 8. The mean score increased based on the pre-test and post-test mean scores.

Table 8
Summary Statistics for the Experimental Group Attitudes Towards Science Scores

Variable		Post-test	Pre-test
Attitudes towards Science	*M*	2.99	2.45
	SD	0.471	0.459

The research conducted a comparison of the overall mean square using the paired sample t-test and it was found to be significant at (t = 4.666, df = 23, p = .01), with a difference of (.544), indicating a significant increase (p = .05) in the experimental group's mean in light of the attitude of the students towards science as shown in table 9.

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Table 9
Results of Paired Sample t-test for Variable

Variable	*t*	*df*	*p*
Attitude towards Science			
Experimental group	4.66	23	.001

Moving on with testing of the (i.e., there is no significant difference in the level of pre-test and post-test earning outcomes scores among experimental groups), paired sample t-test was carried out to know if the mean score in the learning outcomes of students was significant based on pre-test and post-test scores. The overall learning outcomes of the experimental group's pre-test had a mean of (M = 2.60), with standard deviation of (SD = 0.307), while in the post-test the mean was (M = 3.25, with standard deviation score of (SD = 0.576) as displayed in table 10, indicating increased scores following the implementation of learning technique.

Table 10
Summary Statistics for the Experimental Group Learning Outcomes Scores

Variable		Post-test	Pre-test
Learning Outcomes	*M*	3.25	2.60
	SD	0.576	0.307

The research compared the overall mean score of the pretest and posttest for the experimental group using paired sample t-test, after which it was found to be significant at t (4.842, df = 23, p = .01), with a mean score difference of (.651), and a significant increase of (p = 0.05). The detailed results are presented in table 11.

Table 11
Results of Paired Sample t-test for Learning Outcomes Variable

Variable	*t*	*df*	*p*
Learning Outcomes			
Experimental group	4.842	23	.001

Discussion

The aim of this research was to examine the AR application's effectiveness in the attitude of primary school students suffering from learning disabilities, towards basic science, and to identify the different effects of AR technology on their learning outcomes. The AR application development had its basis on the science teaching material specified in the research framework and the development was made under the feedback of field experts, technical experts, and teachers. Prior to collecting data, students were instructed on basic science lessons in the span of two weeks through AR technology, which basically provided them a learning experience through it. Based on the results, the students with learning disabilities showed a positive attitude towards the application during the instruction. AR essentially facilitated a positive environment in the classroom that is distinct from the traditional classroom, which was assumed to promote the positive attitude of students towards learning basic science. The research results showed that AR application assisted in the students' development of positive thoughts about science lessons and in enhancing their attitudes towards their learning environment. In other words, the use of AR technology benefited the educational environment and provided interactive and proactive learning environment through reality enhancement (Sirakaya & Cakmak, 2018). According to literature findings, AR teaching material provided positive contributions to the level of attitudes, willingness, enthusiasm, moti-

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vation, self-confidence, academic achievements and persistence and readiness of students. Lack of evidence concerning the direct contributions of AR to students with special education needs did not negate them. This highlights the contribution of technology-centered environments in education (Alghabban et al., 2017; Ayres et al., 2009; Bakker et al., 2016).

To begin with, Akir and Korkmaz (2019) showed that AR technology materials enhanced the interest of students with special needs towards the studied subject, and Delello (2014) revealed that AR technology improved the student's interest towards lessons. AR application also improved the interest of students and directed it towards materials of learning (Ibili & Sahin, 2013), which significantly heightened their attention towards learning, particularly students with vision and hearing problems, retarded growth and behavioral problems, and those with special education needs (Cakir & Korkmaz, 2019). In the same line of study, AR assisted students to learn more easily and more effectively, increasing their interest towards learning procedures (Ho et al., 2011). The findings indicated significant differences between students exposed to AR technique of learning and conventional learning, and the total score of attitudes towards basic science subject also had significant differences between the two groups, with the AR group being higher. This is indicative of the fact that AR application usage could be effective in enhancing the interest and attitudes of students with learning disabilities. This was supported by Chen et al.'s (2016) finding that showed AR to be capable of assisting students with ASD to display their feelings and status and be aware of different circumstances. Also, Pradibta (2018) revealed the way AR enlightened the students learning and directed their attention towards the learning process, while Karamanoli and Tsinakos (2016) revealed the advantages that AR tool can provide students in terms of transforming their learning process to a more stimulated and entertaining process. It paved the way for dyslexic students to be more interactive while learning and gaining new experiences. The findings of this research are in line with that of prior studies in literature, where students suffering from disabilities can be made more inclined towards learning in a technology enriched classroom surrounding.

Learning Outcomes

The findings of this research revealed that students with special needs enhanced their learning outcomes through the AR application used for basic science lessons. AR technology usage significantly affected the outcomes of students' learning, indicating that the use of such technology was an effective tool, particularly when used with disabled students. Notably, AR supported the learning outcomes of the students in a way that traditional classroom was not able to. In the same line of study, Delello (2014) stated that AR had a key role in the learning of students, urging their participation and interaction in class and enabling their deeper understanding of subjects. AR technology was thus an effective support learning and teaching tool in the education realm (Hsu, 2017; Tian et al., 2014), through the advantages reaped from it. In addition, AR technology was capable of easing learning among students and their understanding of the content material, which in turn, affected their learning capabilities. It familiarized students with the study and its activities boosting their interaction in the process of learning. In fact, Karamanoli and Tsinakos (2016) indicated that AR enhanced the learning activities provided to students, especially those with learning disabilities from simple and static to interactive. The differences in pre-test and post-test may be attributed to the visual support learning mentioned in Cimer's (2012) study. AR technology facilitated visual-aided learning and teaching, where students could easily learn through visual aids. It also facilitated the participation of the students, their concept retention through the tools (visual and audio), promoting their connection of ideas and concepts.

According to the research findings, significant differences were found between the two groups in light of learning outcomes, using learning materials provided by AR technology in a way that AR technology affected such outcome among dyslexic students in the experimental group. Literature generally found significant effects of AR technology on learning outcomes for students (with and without learning disabilities) in many ways, enabling them to benefit from its educational contributions (e.g., Bacca et al., 2014; Kellems et al., 2020; Lorenzo et al., 2019; Radu, 2014). There are several reasons cited in literature as to the use of AR in learning and they include flexibility in instruction designs, support of spatial visualization/audio, enhancement of communication skills, enrichment and provision of meaningful learning and transference of knowledge (Cakir & Korkmaz, 2019). AR provides interaction with a 3D view of the object from different angles that enhances the students' skills and abilities as well as provides them with the skills to practically apply the object (Cheng & Tsai, 2013; Hsiao & Rashvand, 2011). AR technology further provides timely feedback in real-time interaction, leaving the control

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of learning in the students' hands (Bujak et al., 2013; Kucuk et al., 2015; Yuen et al., 2011) and AR technology is basically a combination between virtual and real world elements established in a single environment through images, data and real world contents (Solak & Cakir, 2016). The need for AR technology has been highlighted in literature with several studies indicating the requirement of using visual teaching and learning materials and contents (multimedia design and computer simulations) to assist the understanding of concepts (Cimer, 2012; Mayer, 2009). The use of AR multimedia among children suffering from ASD to enhance their communication skills, was examined in Taryadi and Kurniawan's (2018) study. The authors reached to the conclusion that PECS generated a development of communication ability among the children when comparing pre-test and post-test scores. In the same way, Lorenzo et al. (2019) examined the effectiveness of AR in enhancing the social skills of 11 autistic children. Based on the reported results, the students in the experimental group displayed enhanced social schools but insignificant differences were revealed. In addition, Kellems et al. (2020) dedicated his recent study to investigating the AR effectiveness in teaching mathematics to middle school students that had learning disabilities. The students obtained good scores, with improved problem-solving skills after the intervention.

Moreover, Yalcinkaya (2012) maintained that the development of social skill education in the computer environment fitted with web-based distance education system among children with mild mental disabilities. The children participated in various activities (e.g., drawing on a drawing tablet, shooting short videos within the planned framework, participating in technology-enriched extracurricular activities). Based on the research's results, extracurricular activities driven by technology had a positive influence on the students' cognitive and physical development. Meanwhile, Dogan's (2015) study on the effects of technology-supported extracurricular activities on students that had mental disabilities reached to the conclusion that such activities positively affected the students' cognitive and physical development. Also, Dunleavy et al. (2009) highlighted the potential of AR in enhancing learning among students, with its distinct ability to develop immersive hybrid learning environments, which facilitated the development of the students' critical thinking, problem solving and communication through collaborative exercises. Furthermore, AR was integrated in communication interventions through the connection of elements of augmented and alternative communication and applied behavior analysis strategies (STAR) in the research by Almeida et al. (2015). AR also managed to improve the students' memory and social skills. From the above findings in literature, the present study's investigation is justified.

Conclusions and Suggestions

The augmented reality (AR) technology has proven suitable for school environment. Promising innovation paves the way for teaching and learning opportunities and enhances students' success. AR technology contributes effectively towards achieving optimum results when using AR instruction, one of the best learning methods for students with special needs. It supports the inclusion of students and instructors in selecting the right and most effective instructional method, to enhance the learning outcomes and to ensure that students have the opportunity to express positive attitudes, increased interest, focus, attention and interaction. The natural usage of AR technology in learning is crucial as the AR is a combination of the physical and virtual world which is directed towards improving the learning environment through providing more visual and audio information through the use of computer and mobile technologies. The combination of real and virtual objects, AR enables the visualization of abstract concepts and complex spatial relationships and the experiencing of phenomena in a way that cannot be experienced in the real world, and thus, reinforcing the learning experience, increasing understanding, and enhancing student's motivation, participation, and their engagement. Utilizing the AR technology in the special needs learning process, students could be better engaged in learning. They could also participate in the learning world via their positive attitudes towards science, thus increasing the demand for science and technology-related majors and careers. The findings of the present research provide vital information for instructors and academicians intending to move towards effectively implementing AR technology in their learning process for students with special needs. Although, previous research dedicated to AR as an evidenced-based approach for instructing students with special needs are still few and far between, and as such, in this work, AR instruction is tested using 6th grade students in their science curriculum. The present research's examination is focused on whether grade 6th students with special needs could determine an instruction method in advance that would lead to the most optimum learning, therefore, more research is needed in other students' ages and courses. The research's sample does not promote generalization of results to the general population

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of students with special needs, as the research results are based on the participating students in the study. Hence, the sample of the research should be extended to other students. Regardless of the enhanced evidence of the mean scores of the students, the research experiment spanned only 4 weeks and thus, a longer period of research is needed for conclusive results. The research is also limited in its data collection method, which is the self-report measures, as this is characterized by inflated biases, influenced by the existing social desirability. Thus, this research recommends that future authors investigate the research objectives through the use of mixed method approach (quantitative and qualitative methods).

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