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The Study of Augmented Reality Typhoon Resilience Education for Elementary Special Education Students: A Case Study in Taiwan

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Abstract: ***Every year, the period from July to September is the active typhoon season for Taiwan, often bringing numerous disasters that cause loss of life and property damage to the public. However, in traditional educational settings, most children have only a basic understanding of typhoons. They don't know how to react when a typhoon approaches, and they don't know how to deal with the aftermath. Therefore, this study conducted an analysis of teaching effectiveness by integrating augmented reality (AR) into picture books and using 5th-6th grade special education students from an elementary school in New Taipei City as the teaching subjects. The students were randomly divided into an experimental group and a control group. The experimental group received instruction through AR-integrated picture books, while the control group received traditional teaching methods. Statistical tests were also used to examine the difference in students' learning outcomes. The results of the study indicate that integrating AR into typhoon resilience education significantly improves students' learning outcomes; in addition, it increases students' motivation in the classroom and facilitates positive peer interactions.***

Keywords: augmented reality, typhoon resilience education, special education, elementary school

1. Introduction

In Taiwan, the period from July to September is the active season for typhoons, which, along with the plum rain season, play an important role in replenishing water resources. Although there is a protective barrier from the high mountains, typhoons often bring numerous disasters, such as strong winds, heavy rain, landslides, mudslides, and lightning, which can even have a negative impact on people's lives and property. Therefore, typhoon preparedness education is very important for students in Taiwan. However, students with special educational needs often have difficulties with abstract comprehension and attention deficits, so teaching often requires creating concrete and engaging materials or guiding students to real-life situations for practice to improve their understanding and maintain their motivation to learn.

Therefore, this study incorporates AR technology into storybooks for teaching typhoon resilience, allowing special education students to use tablets for AR to teach typhoon prevention knowledge and explore the impact of disasters. This study primarily uses AR storybooks as teaching tools to educate elementary special education students. AR has significant implications in teaching; it can enhance visual learning, provide high interactivity, simulate real-life situations, and improve students' motivation and retention. Through AR teaching, it helps students gain a concrete understanding of pre-typhoon preparations, necessary response skills during typhoons, and post-disaster handling methods. In addition, this study uses the Ministry of the Interior's typhoon prevention education resources and the Ministry of Education's disaster prevention education information website as the main source of learning content.

2. Literature Review

This section reviews relevant literature and research data based on this study topic. Therefore, this section explores the application of existing typhoon or disaster preparedness education and AR applications in the classroom.

In terms of literature relevant to AR disaster education, Chen (2018) explored the benefits of using AR in teaching disaster prevention to school children. He found that integrating AR multimedia into the classroom not only improves the quality of teaching, but also effectively communicates educational content, increases children's interest in learning, and achieves effective interactive learning outcomes. Chiu (2021) also took landslide disaster prevention education as an example and found that using AR technology to support landslide disaster prevention curriculum had a positive effect on students' willingness to learn and also improved their learning outcomes in disaster prevention literacy. In addition, Safitri, et al. (2024) applied Ecoliteracy learning design with an AR-based approach to increase students' knowledge about environmental protection and efforts to reduce the impact of flood risk. Their study showed that AR Ecoliteracy media has an assessment score percentage of 90.46% with very good criteria, the SETS learning process with AR Ecoliteracy media can make students more interested in learning the material, but in the field of science still needs support from teachers. They concluded that the use of AR media is needed in education, especially with Generation Z. In addition, Polikarpus et al. (2024) applied AR holograms in firefighter training. They analyzed three hologram characteristics: dimension, scalability, and interactivity, and report the results of using five holograms (one 2D and four 3D) in a training application called FightARs. The holograms were tested on

in-service firefighters and commanders to improve their knowledge in pre-disaster traffic incident training involving hazardous materials. Their results indicate that a full-scale holographic scene is useful for training situational awareness. Their study underscores the need for extensive testing and incorporation of AR into first responder training prior to its application in the field.

Furthermore, for the AR technology itself, as AR has been widely used as an interactive technology in various learning and educational environments. However, a previous systematic review lacked a framework to identify the different types of AR used, the types of technology employed, and the types of augmented parameters involved. Hidayat and Wardat (2023) attempted to review current studies using AR learning to support science, technology, engineering, and mathematics education. By reviewing 42 related articles. they found revealed that three popular types of AR design were used, they are marker-less AR, marker-based AR, and projection-based AR. They also indicated that most scholars used cameras and object markers as technological modalities to support education.

3. Methodology

The teaching tool used in this study was the AR drawing book (as shown in Figure 1) for typhoon prevention. It is an AR application launched by the Virtual Disaster Prevention Center, Fire Department of the Ministry of the Interior, Taiwan, which is mainly about typhoon prevention knowledge and disaster prevention safety rules. For the traditional lecture-based teaching, the Disaster Prevention Promotion Manual of the Fire Department of the Ministry of the Interior is used. Students taught with AR integration are set as the experimental group, while students taught with the traditional lecture-based method are set as the control group. In this study, the fifth and sixth grade special education students of an elementary school in New Taipei City were the subjects of the study, as shown in Table 1.

Figure 1: The AR app download page
Source: Virtual Disaster Prevention Center, https://nfaxr.com.tw

Table 1: Study sample groups

Group	Fifth grade	Sixth grade	Total
Experimental	5	3	8
Control	5	3	8
Total	10	6	16

Meanwhile, the following items are set the same for these two groups, they are:

- Teachers: Teachers in both experimental and control groups were the same to ensure the consistency of teaching styles and attitudes.
- Teaching time: Both the experimental and control groups were taught in one lesson (40 minutes) per week for three weeks.
- Test Questions: Both the experimental group and the control group used the same test questions prepared by the researcher.

Finally, the small sample t-test is used to compare the difference in means between two population groups. The null hypothesis and alternative hypothesis are as follows.

$$H_0 : \mu_{traditional} >= \mu_{AR}$$
$$H_1 : \mu_{traditional} < \mu_{AR} \quad (1)$$

4. Results of Experimental Teaching

The experimental lessons were held on Mondays and Tuesdays from March 4, 2024 to March 18, 2024 during the morning study period. The experimental group and the control group had three lessons each. The teaching scenes of these two lessons are shown in Figures 2 and 3.

Figure 2: Traditional lecture-based classroom scene

Figure 3: AR integration teaching scene

In this study, MS Excell 2019 was used for basic data analysis and validation. First, the mean and coefficient of variation of the two sample groups were calculated, as shown in Table 2. The calculation results showed that the rounded mean of the AR integration teaching group was 91, which was higher than the rounded mean of the traditional lecture group of 77, which implied that the learning effectiveness of the experimental samples using the AR integration teaching group was higher than that of the traditional lecture group; in addition, the coefficient of variation of the AR integration teaching group was 0. 044, which was much lower than that of the traditional lecture group of 0.102, which means that the learning effectiveness of the experimental samples adopting the AR integration teaching group was higher than that of the traditional lecture group, which means that the learning stability of the AR integration group is better than that of the traditional lecture groups.

Table 2: Analysis of typhoon prevention scores

Group	Control	Experimental
Average	76.75	90.75
Standard deviation	7.851296526	3.9551052
CV	0.102297023	0.043582426

In addition, the results of the small sample t-test are shown in Table 3. The one-tailed P-value of 0.00024757 is much lower than the α-value of 0.05, which means that there is a significant difference between the two population means. This means that the learning effectiveness of the AR integration teaching method is higher than that of the traditional lecture teaching method.

Table 3: Hypothesis test results of the scores

	Control	Experimental
Average	76.75	90.75
Variance	61.64285714	15.64285714
Number of observations	8	8
Pooled variance	38.64285714	
Hypothetical mean difference	0	
Degrees of freedom	14	
t-statistic	-4.504259639	
P(T<=t) one-tailed	0.00024757	
Critical value: one-tailed	1.761310136	
P(T<=t) two-tailed	0.000495139	
Critical value: two-tailed	2.144786688	

5. Concluding Remarks

This study investigated the effects of integrating AR into typhoon resilience teaching for elementary special education students. According to the results of experimental data analysis, the stability of students' learning outcomes was better in the AR integrated teaching group. Meanwhile, AR-integrated teaching can enhance students' learning motivation.

Moreover, based on the results of this study, this study proposes the following recommendations for teachers in the teaching field and for future researchers to expand other disaster resilience education. Since this teaching experiment was set up for special education students in the 5th-6th grade of elementary school, the future study can be extended to students in other grade levels. In addition, the scope of this teaching experiment is limited by the number of students in the sample school, only 16 samples. The future study may consider expanding the scope or including all counties and cities in the nation to improve the reliability and validity of the results of the experiment.

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