Effects of Drone Technology and Virtual Reality on Student Engagement, Visual Attention, and Learning Experience

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Abstract. Despite the fact that there currently exists no data to support their efficacy, virtual reality and drones are increasingly being used in schools. This study looked into students' involvement, visual attention, and learning experiences in relation to drone technology and virtual reality. The study used an experimental approach to investigate how drones and virtual reality effect students' engagement, attentiveness, and experiences. Ten students from each of the three domains participated in the study. Their post-intervention engagement grew by 41.2%, their visual attention increased by 94.6%, and their learning experience increased by 94.6%. According to the research, using drones and virtual reality improved students' engagement, visual attention, and learning experience.

Keywords: Drones, virtual reality, student engagement, visual attention, and learning experience

1 Introduction

Virtual reality and drones in education are assisting schools in undergoing huge digital changes and transitioning into collaborative, interactive, and hyper-connected educational spaces. Instructors can use drone technology to teach new mapping and surveying techniques and conduct environmental research, wildlife research, oceanography, media, and engineering (Bai & Chu, 2021). Drones have also become essential tools for improving engagement, visual attention, and commitment among learners (Yepes et al., 2022). Researchers have shown that students who are more engaged and attentive in the classroom are likely to score higher grades in their exams (Fokides et al., 2017). Some higher education courses rely on drones to prepare learners for the growing use of unmanned aerial vehicles (UAVs) in various industries (Bai & Chu, 2021). This study examines the effects of drone technology and virtual reality on student engagement, visual attention, and learning experience.

Although there is a growing demand for technology in education, a proper implementation strategy requires data regarding effectiveness and efficiency. The use of virtual reality and drones in education has not received significant research and may be difficult to implement based on current knowledge. The researcher felt that additional study is required to enable informed

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choices among educators. Most of the current technology being used in the classrooms is applied as a tool, rather than a source of new information (Bai & Chu, 2021). There are a few schools, however, where drone technology is taught to potential pilots, especially in countries with growing demand such as China (Yepes et al., 2022). This study explores the use of drone technology as a tool to enhance education, not as a source of new knowledge. The three targeted areas include student engagement, visual or spatial visualization, and learning experience.

2 Literature Review

2.1 Virtual Reality (VR) and Drones

Virtual reality is a type of computer-generated environment that makes virtual objects appear and be immersive. Virtual reality (VR) can be used in the classroom to explore the surrounding environment, human anatomy, technologies, buildings, spaces like deserts or game reserves, medical simulations, and many other areas. According to Bai & Chu (2021), the use of VR has become increasingly important for explaining features that students are more likely to understand better in visualization than reading. For instance, VR can be used in performing human anatomy or exploring a nearby river to understand aquatic life. VR provides a unique experience to learners because it immerses them in the environments that they are supposed to learn (Yepes et al., 2022). Apart from capturing attention, VR makes learning more interesting and may encourage those with difficulties in following theories to make more commitments to education. Besides, Fokides et al. (2017) add that visualized images last longer in memories than textual information.

However, VR differs slightly from drones because the drones provide the actual images or videos of the targeted environments. For instance, if the classroom wants to identify the number of vehicles using a particular road, a drone mounted with high-definition cameras can be flown to the desired areas for real-time observations (Rábago & Portuguez-Castro, 2023). Drones are more effective in visualization because they provide actual images in real-time, rather than computer-generated graphics (Yepes et al., 2022). However, VR is still more effective in exploring areas that may be difficult to observe using cameras, such as the internal organs (Bai & Chu, 2021). The drones also enable educators to improve motor skills and hand-eye coordination among learners (Fokides et al., 2017). Students can also gain both intellectual and creative skills that enable them to solve complex problems in society.

2.2 Use of Drones and VR in Chinese Schools Selecting

While VR has been part of Chinese education for a while, most schools are beginning to combine the two or use drones separately. China is one of the world's largest manufacturers of drones. The cost of drones is much more affordable for most schools within the country (Gu et al., 2022). However, the use of drones has met significant challenges in various schools. One of the biggest challenges is the lack of drone pilots to enhance efficiency in using them in the classrooms (Rábago & Portuguez-Castro, 2023). China does not have sufficient drone pilots despite being one of the largest manufacturers in the world (Bai & Chu, 2021). Several universities and colleges have rolled out training programs to develop more pilots who can use drones for both education and other purposes. The Beijing-based TT Aviation Technology College is one of the institutions providing drone-related courses to train more pilots for the growing industry (Yepes et al., 2022). In schools such as TT Aviation Technology, drones are used as sources of knowledge, rather than tools. In such a case, students are not only taught how

to fly the drone but also how to create each part. This differs slightly from the way drones are used among third-grade learners.

2.3 Effects of Drones and VR in the Classrooms

According to Sivenas & Koutromanos (2022), drones help in building motor skills and hand-eye coordination. For a long time, educators have often relied on sporting activities to build hand-eye coordination among learners. Drones provide alternative ways of building these skills even without participating in outdoor activities (Rábago & Portuguez-Castro, 2023). Drones require learners to focus as they use their hands and eyes to navigate through space. Drones have also been found effective in building motor skills through depth perception (Gu et al., 2022). For instance, students can calculate the distance that the drone has covered and use their findings to calculate the time it would require to remain in the air while performing specific tasks (Bai & Chu, 2021). Learners from as low as grade three may benefit from the essential motor skills as well as hand-eye coordination that they gain from using drones.
Drones are also effective tools for teaching coding, laws of physics, mathematics, and physical activities. Drones have inbuilt artificial intelligence or robots that enable them to enhance precision and accuracy while taking videos and photographs (Sivenas & Koutromanos, 2022). The development of drones can provide significant opportunities for students to learn how to code. Yepes et al. (2022) believe that even those in early education stages can benefit from coding and apply such valuable skills in later stages of their lives. Drones are also effective tools for teaching mathematics in classrooms. Most students in the early stages of education may not understand the value of learning subjects such as mathematics until they see practical applications (Bai & Chu, 2021). Drones are frequently used by teachers to educate students how to compute the distance between two points, recommend a direction, and comprehend the importance of mathematics in addressing real-world problems (Fokides et al., 2017). Drones provide real-world applications of scientific, technological, and mathematical concepts and calculations.

3 Methodology

This study used an experimental methodology to investigate the impact of drone technology on visual attention, engagement among learners, and learning experience. The study's major question is, "Does using drones and virtual reality in the classroom enhance student engagement, visual attention, and learning experience?" The inquiry began with the collection of pre-test data from participants. Students with low engagement (3.0 or below), poor visual attention (3.5 or lower), and poor outcomes (4.5 or lower satisfaction rate) were targeted in the experiment. Drone and virtual reality technologies were utilized separately to boost engagement, attention, and experience scores. The findings would be used to establish whether the two technologies are useful tools for improving learners' attention, engagement, and overall satisfaction.

3.1 Research Participants and Procedure

Participants were third-grade students with low engagement (3.0 or below), poor visual attention (3.5 or lower), and unsatisfactory experience (4.5 or lower satisfaction rate). The study had a total of ten students. Jane, Robin, Xvir, Rand, Ruth, Tyler, Tinker, Mogi, GiG, and Ddi were among those who took part (not their real names). Their baseline scores were acquired before to the exam to aid in comparisons at the conclusion of the experiment. A sentence was read to the participants that described a classroom with equipment such as desks, chairs, books, notebooks, pencil cases,

whiteboards, blackboards, compasses, and backpacks.. Students were also given pictures of the classroom to help them identify the items, including their numbers, color, and positions.

During the first intervention, students were immersed in the classroom using VR technology and asked to identify the same items. In the second intervention, students were immersed in the classroom using a drone being flown by a teacher. They were then asked to name all the items they see on their screens. Test scores were then awarded based on the correct identification of the items, including their numbers, color, and positions. Correct answers were awarded 10 points while wrong answers got 1 score. The average for the final scores was then calculated for each student and the results are shown in tables and graphs (see Fig 1).

A linear regression equation shown below was used to determine the relationship between the variables. The main variables include interventions (independent) and test scores (dependent). For instance, the linear equation helped in determining if there is a linear correlation between the use of drones and improved visual attention among students. The following was the chosen linear equation with beta and alpha coefficients.

The equation that was used in this study was as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \varepsilon \quad (1)$$

4 Results and Discussion

According to Ware (2017), both virtual reality and drones generate significant curiosity among learners. Most students may feel excited to see how their classroom appears in virtual reality or drone videos. The study conducted by Zhao & Wu (2022) found that curiosity and engagement go together in most learning environments. Students are more likely to become engaged if they feel curious about a new source of information or tool used in the classroom (Fung & Watts, 2017). Drones and virtual reality are new tools that will often draw significant curiosity among learners (Rábago & Portuguez-Castro, 2023). The main advantage of drones and VR is the capacity to draw and sustain curiosity among learners. Since drones are used for exploring targeted environments, students will ask questions as they interact with more materials in the video feeds. The use of VR and drones may also generate a strong sense of enthusiasm among learners, encouraging them to keep exploring their environments.

4.1 Student's Engagement

The above data show significant improvement in student engagement in the post-intervention test scores. The students experienced about 41.2% improvement in their classroom engagement. VR and drones drive engagement through hand and visual coordination. The visual aspects brought by both VR and drones capture the attention of learners while the activities such as flying the drone or setting flight codes enhance engagement. Bai & Chu (2021) argue that drones or VR enhance engagement among learners because it enables them to interact with the environment. In the experiment, for instance, students were asked to name and count various items they see in the classroom (Yepes et al., 2022). The items were clearly listed to guide their vision as they browse through the video. As students interact with their environment, they ask questions regarding what they see and do not understand (Fokides et al., 2017). For instance, students may ask why the classroom has both white and blackboards. Students may also ask about the purpose of certain charts they see on the classroom walls. The study proved that teachers can use tools

such as VR or drones to improve engagement among learners who experience difficulty in concentrating on their tasks.

4.2 Visual Attention

Visual attention or spatial visualization is the student's ability to focus on something or an object or target in the environment. Many students try to avoid or minimize information overload by focusing and picking up what is important to them (Yepes et al., 2022). However, in the process of selective listening or watching, some students end up distracted by other elements leading to a loss of attention (Hall & Wahab, 2021). Some students can hardly concentrate due to other challenges such as learning disabilities or external distractions in the learning environment. Visual attention is a precondition for visual recognition. If students fail to focus on what they see, they are unlikely to accurately identify the objects (Carnahan et al., 2016). Visual attention enables clear visual processing and decision-making among learners. However, the presence of distractors in the classroom has prompted many teachers to apply certain interventions to students who have difficulties focusing (Sattar et al., 2017). Virtual reality and the use of drones are examples of critical interventions that educators are using to improve spatial visualization.
The study proved that the use of drones or virtual reality can improve virtual attention among learners with poor attention skills. The research found a significant increase in visual attention scores between the pre-test and post-intervention test scores. Visual attention increased by over 94.6% between the pre-test and post-intervention scores. One of the factors that led to such a sharp increase is the immersive atmosphere that engages students and challenges them to explore the environment (Birtchnell & Gibson, 2015). Both VR and drones provide immersive environments that are fully engaging by using both visual and hand coordination (Leigh et al., 2020). Students were required to identify items in the videos, count them, and name their colors and positions. The task was fully engaging and left very little or no room for distraction. The students had to focus on the videos and images to make correct identifications and calculations.

4.3 Learning Experience

The students achieved both hands-on experience and 3D learning experience from both experiments. According to Carnahan et al. (2016), the learning experience is often determined by what students feel about the classroom content. Those who believe that the classroom content is inadequate, difficult, or unclear may have lower satisfaction scores. Before taking the experiment, students were asked about the satisfaction rates to develop a clear image of their learning experience. The pre-test showed that students had between 3.1 and 4.5 satisfaction rates, far much lower than the average scores. Since the chosen students also had difficulties in visual attention and engagement, they could indicate lower satisfaction scores. However, during the intervention, students had to coordinate their actions and thoughts using complex eye-hand coordination (Yepes et al., 2022). This gave them a hands-on-experience, a crucial skill that they can use in the future (Ng & Cheng, 2019). The eye-hand coordination was also a crucial experience that will enable students to remain attentive within and even outside classrooms.

The 3D learning experience was also effective in boosting curiosity and overall satisfaction among learners. The VR's 3D software provides an immersive experience even if the videos and images do not present the actual scenes. During the experiment, the researcher found that operating drones gave students 3D sensations of their surroundings. Students were also able to use a remote-control system to move the drone around the classroom and study the outside environment. It was a whole new experience for many learners who had never operated drones before the intervention. It was also a complete departure from the normal delivery of instructions

where a teacher talks for almost an hour while learners participate by answering questions (Bai & Chu, 2021). Most students urged the instructor to create more opportunities for using the drone because it gave them a whole new experience. The satisfaction scores also rose significantly among learners who found the new delivery very informative, action-driven, and interesting.

Table 1 Student engagement

Students	*Engagement*	*Attention*	*Experience*	*Pre-Test Average*	*Engagement*	*Attention*	*Experience*	*Post-Intervention Average*
Jane	3.5	2.7	3.1	**3.1**	7.8	7.1	6.9	**7.3**
Robin	2.7	4.5	3.7	**3.6**	6.5	6.3	7.3	**6.7**
Xvir	2.9	3.3	2.9	**3.0**	7.1	7.2	6.9	**7.1**
Rand	4.5	3.7	4.1	**4.1**	8.3	7.9	8.1	**8.1**
Ruth	3.9	4.1	3.5	**3.8**	7.1	6.4	6.6	**6.7**
Tyler	4.7	3.5	4.5	**4.2**	6.8	7.3	6.1	**6.7**
Tinker	3.5	3.9	2.9	**3.4**	6.5	7.8	6.3	**6.9**
Mogi	3.7	3.5	3.9	**3.7**	7.3	7.1	7.5	**7.3**
Gig	2.5	2.9	3.3	**2.9**	5.9	6.3	6.9	**6.4**
Ddi	4.9	4.5	4.7	**4.7**	9.2	8.9	9.1	**9.1**

Table 1 the student's engagement, attention, pre-test average values, experience comparing with the engagement, attention and experience after the test as well. Figure 1 showcases the values in chart type to show the changes in the values compared to pre test scores and post test scores. Figure 2 shows the content quality and user experience. Figure 3 shows the same values in visualization method. With plain eyes we can see the change curve climbed up after post intervention tests,

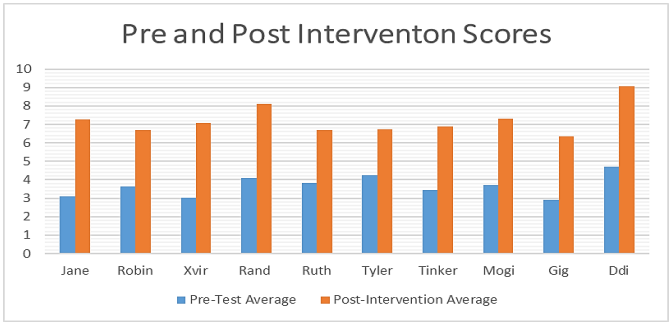

Fig 1. Graph showing the pre-test and post-intervention test scores.

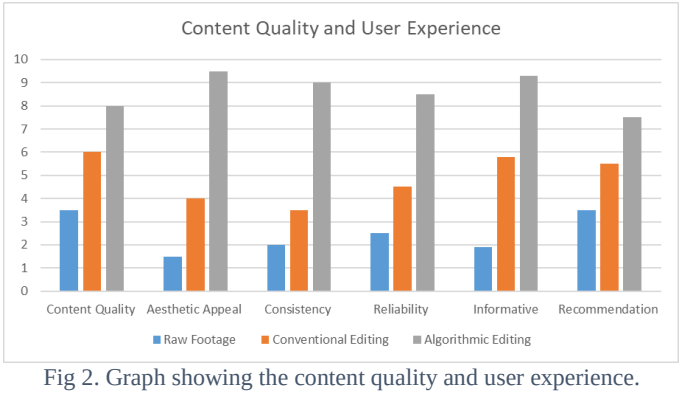

Fig 2. Graph showing the content quality and user experience.

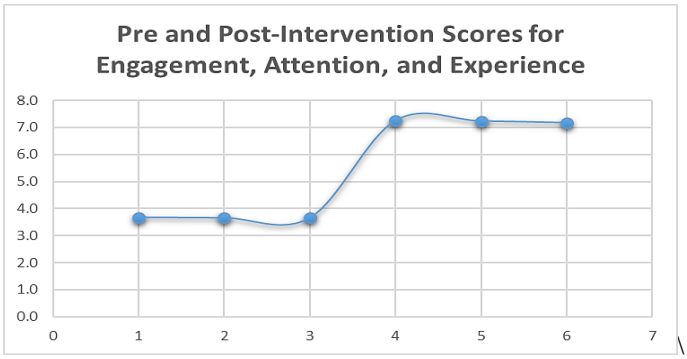

Fig 3. Graph showing significant improvement in engagement, attention, and experience after the intervention

5 Conclusion

Technologies used in the classroom to drive strong performance among learners. Some of the benefits of drones and VR include intellectual stimulation, the development of motor and soft skills, studying complex features, and exploring the surrounding environment. The study used experimental design to study the effects of drones and virtual reality on students' engagement, attention, and experience. A total of 10 students who had difficulties in the three domains were selected for the study. Their post-intervention scores increased by 41.2% for engagement, 94.6% for visual attention, and 94.6% for the learning experience. The results indicate that the use of drones and virtual reality had positive effects on students' engagement, visual attention, and learning experience. The study also supports the use of innovative tools in the classroom to improve the performance of learners.

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