Augmented Reality in Ocean's Secrets: Educational Application with Attached Book for Students

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***Abstract*---**The aim of this paper is a project which uses of Augmented Reality (AR) as a method for edutainment learning instrument to promote and encourage learning among students in this pandemic period. An AR application is developed together with a physical book called the Ocean's Secret. This application projects animated 3D models of the sea animals as visualized in the printed book as the students or readers interact with the book. The book Ocean's Secret offers facts about the ocean and marine animals along with fun quizzes, puzzles, coloring activities, as well as educational videos prompted by the AR objects. This book would be a good source as a learning tool during this last 2 years of the pandemic period. AROS application is evaluated via User Acceptance Test and an Observation Study. The findings show that the application has effectively aided online learning and make the learning environment more interesting and engaging. It is hoped that AR education books will assist online education in this pandemic period while at the same time offering students with the sense of excitement they desire.

***Keywords*---**augmented reality, educational technology, online learning, pandemic.

Introduction

In recent studies, designing online educational Augmented Reality (AR) textbooks to play a substantial for online tool in student education. It has become more effective and efficient as compared to traditional textbooks Zhu et al. (2017), which is not going to be exciting for students in an online environment . In the traditional education method, one of the disadvantages is the lack of presentation in transferring complex knowledge that requires elaboration of facts within the given context (Kasinathan et al., 2020). Mahmood (2013), argued that AR technology can significantly improve education by providing enjoyable learning experience as it integrates virtual 3D objects that enhance under-standing, despite in an online environment (Kesim & Ozarslan, 2012; King, 2002).

Through the use of AR, students will enjoy reading a textbook with 3D images such as in solar system or human body system. Using the AR book helps to augmented models which allow students to get a better understanding about the concepts which they are studying. This is an exciting way that can engage students and support the concepts that they have learned offline. According to Emanuel et al. (2020), by interacting with the small displays of objects, students are able to visualize undetectable physical measures and encourages all learners to learn and discover new information every day through a trip of entertainment and learning. Furthermore, AR applications contributes to the growth of new generations who are experimentally proficient while at the same time preparing them to work in a world that is progressively impacted by Science and Technology. AR offers a tremendous new way of learning Science beyond the boundary of physical classrooms (Karagozlu et al., 2021).

To promote this concept, this paper proposed an AR application together with a physical book called the Ocean's Secret. The AR technology allows students to observe virtual 3D sea environment and marine animals by scanning AR objects placed in the textbook. This application is user-friendly and promotes an experiential learning approach, where students encounter Science directly at their own pace and participate in exercises where information is self-discovered instead of passively transmitted (Zhu et al., 2017). The remaining of this paper proceeds as follows. Section 2 presents related work on AR in education. Section 3 presents the AR application for the book of Ocean's Secret called AROS. Section 4 presents evaluation of AROS and Section 5 concludes the paper (Nincarean et al., 2013; Akçayır & Akçayır, 2017).

Related areas

Augmented Reality (AR) exhibits an especially intense User Interface (UI) to setting computing environment. AR systems coordinate virtual data into a physical environment with the goal that the user will see the data as part of their surroundings (Mahmud et al., 2015). AR systems give this administration without limiting the user's whereabouts to a uniquely prepared area (Mahmud et al.,

2015). A user's view of and interaction with the present reality can be improved with augmented reality. The virtual objects view data which the client cannot straightforwardly identify with his or her own sense (Desai, 2018). The statements transformed through the virtual objects enables the client to execute a real-world assignment (Cheung & Slavin, 2012; Song et al., 2004).

New potential outcomes for learning and teaching are also given by AR. The conjunction of virtual objects and real surroundings enables users to picture complex 3D relationship and abstract concepts Hamzah et al. (2021), encounter phenomena that may or may not be imaginable in reality and interact with two and three-dimensional object mixed in reality. Furthermore, researchers are creating important practices to have learning environment enhanced with technology (Yildiz, 2021). These educational advantages have made AR one of the key developing innovations for training throughout the following five years. With regards to augmented reality books in the literature, three similar AR applications in different domain are reviewed. The first book is an activity book by two authors Pamela Dennison and Darren Lutz in 2012. This book tells an exciting story of Gracie, the pink Triceratops, who has some odd guests in her striped socks (Vakaliuk & Pochtoviuk, 2021). The augmented reality part of this book is involved more than the other illustrations and it includes 12 fully realized interactive activities and games that relate to the scenes in the story (Hrastinski, 2009; Clase et al., 2020).

The second interactive book is about the land of the supernatural by (Khan et al., 2021). With spine stinging stories from around the world about all kinds of ghosts and hauntings, this scary book will amuse the reader for hours when they bring the ghosts to life by using their own devices and the associated application. This exciting book brings to life quite literally 10 well-known hauntings from the records of history. Utilizing the interactive AR to enhance the images on the pages, readers are able to visualize and interact with 3D ghosts, which appear to come alive and easy to be manipulated by the user (Khat et al., 2021). Finally, the third book features the animal kingdom that uses a mixed of illustrations and texts for describing the animals in the usual encyclopedia mode. However, when a smartphone is held over the illustrations, fully animated versions of each animal appear, that can be turned and manipulated by the user. These books encourage students to engage with their educational content, giving them an interactive experience that's engaging and fun as well as informational (Palamar et al., 2021).

Augmented reality of ocean's secrets (AROS)

Watching live ocean animals is a dream to many students. While the real-life experience may not be within everyone's reach, augmented reality technology allows such experience to be enjoyed by much wider audience. This paper is set to develop an Augmented Reality (AR) application together with a physical book called the Ocean's Secret. This application projects animated 3D models of the sea animals as visualized in the printed book as the students or readers interact with the book. The book Ocean's Secret offers facts about the ocean and marine animals along with fun quizzes, puzzles, coloring activities, as well as educational videos prompted by the AR objects. The proposed AROS system allows users to view virtual 3D or 2D graphical objects into the real world via the smartphone

camera. AROS projects floating 3D ocean animals on top of the picture in the physical book when viewed from AR application. Users are able to rotate the targeted image of the AR objects to get 360 degrees view from all sides. In addition, the application also plays the sound of ocean and its sea animals (Downar et al., 2010; Ospennikova et al., 2015).

AROS application structure

The application Augmented Reality of Ocean's Secrets (AROS) is developed using a combination of both linear and hierarchical navigational structure. In a linear structure, user navigates sequentially, moving from one page to the next. Meanwhile, in a hierarchical structure, user navigates top to bottom, one branch at a time, with more branches being available at the lower end. Figure 1 shows the navigation structure for AR in Ocean's Secrets (AROS), whereby most of the features designed within the application can be navigated back and forth from any present state (Danchikov et al., 2021; Asri et al., 2021). Development was carried out completely using the Android Studio and Unity 3D Unity is chosen as it provides customization both 2D and 3D objects along with a primary scripting API in C# for both the Unity editor and activities themselves. The library that is chosen for this project is the Vuforia Engine Library. Vuforia keeps the target images as database, therefore can communicate directly with Unity.
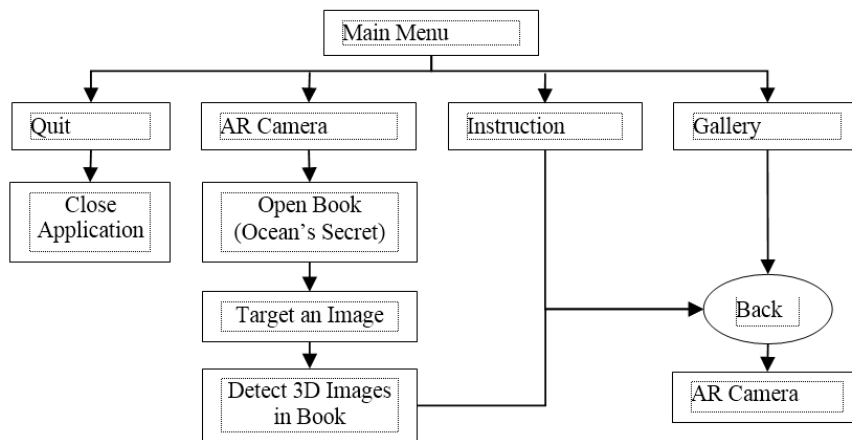

Figure 1. Application structure for augmented reality in the Ocean's Secret

AROS interface

Ocean's Secret contains 58 pages of graphical elements in full color. The book covers topics on the ocean's plants, food chains, ocean facts, I Wonder Shy, coloring activities, quizzes, puzzles, guide for parents, and references. Figure 2 shows the book cover as well as the main page of the AROS application.

Figure 2. Physical book cover of The Ocean's Secret vs. application interface of AROS

The main menu of AROS contains buttons that connect all pages within the application. The button AR Camera is to activate the smartphone camera, Instruction is the page that guides how to use the application, and Gallery stores pictures of the ocean animals, and finally quit to exit. This application can be used independently from the book altogether. Figure 3 shows the book page that points to the interactive AR objects.

Figure 3. AR objects and the information it provides.

Once detected, AROS application will project 3D or 2D animated ocean animals with ocean sound effects on top of the target images via the smartphone. The camera will auto focus the target image to get a better detection of the target image and can be rendered from all sides. AROS also pops a video playback with certain AR objects in the physical book. Figure 4 shows the augmented content of AROS, which are the animated animals as well as a video playback.

Figure 4. Projected animated 3D and 2D objects by AROS as well as a video playback

Evaluation

In order to evaluate the proposed Augmented Reality in Ocean's Secrets (AROS) application, three types of evaluation were carried out: a User Acceptance Testing (UAT), a survey and an observational study.

User acceptance testing

A User Acceptance Testing (UAT) is the process which test the usability of both AROS and the physical book to satisfy the user requirements. The test plan for UAT consists of 9 evaluation aspects to be rated between 1 (very bad) to 5 (excellent). The aspects include book graphics quality, book layout, 3D graphic quality, 3D animation quality, sound quality, user interface ease-of-use, clear instruction, gallery, and over-all application. There were three testers tested, rated, and commented the AR application, AROS. The first tester was a child with his parent's guide, the second tester was one a teacher and the third tester was a ten year old child picked randomly at school. The average score for every tester is shown in Table 1.

Table 1
UAT scores for all three testers

Aspects	Tester 1	Tester 2	Tester 3
1	5.0	5.0	4.0
2	5.0	5.0	4.0
3	5.0	4.0	4.0
4	5.0	5.0	4.0
5	5.0	5.0	4.0
6	5.0	3.0	5.0
7	5.0	5.0	5.0
8	5.0	4.0	3.0
9	5.0	5.0	3.0
Sum	45.0	41.0	38.0
Average	5.0	4.5	4.2

The overall result of the UAT is s 4.56/5.00, which is satisfactory and all the testers like the application and found it something new and interesting for them. In addition, some of the suggestions such as adding more features like moving and controlling the 3D animals through the mobile screen and adding multi-language capability. Some users also pointed out the disadvantage of the application such as the application user-interface needs icons, and the book needs pictures more than texts. All in all, the comments and feedbacks of the testers are good for the future enhancements. The second method to conduct UAT is through survey questionnaire. The questionnaire consists of 13 questions formulated based on the literature to gauge the impact of edutainment learning instrument such as AROS in promoting and encouraging teaching and learning. The questionnaire was distributed to 30 adults: both teachers and parents of students at Al-Huda elementary school. The responses were recorded and analyzed as follows.

- Question 1. The usage frequency of smartphones and tablets by students is mostly very frequent. The findings are shown in Figure 5.
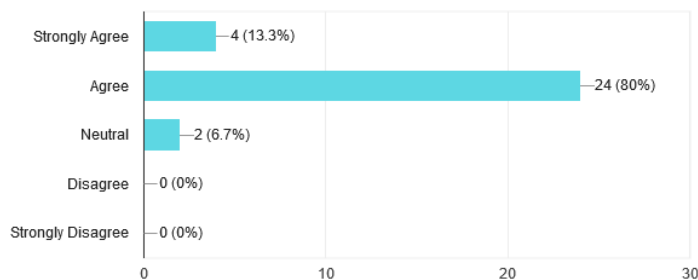

Figure 5. The finding shows that most participants answered with Agree and strongly agree that means they use their cell phone day and night. Having AR application will maximize the usage

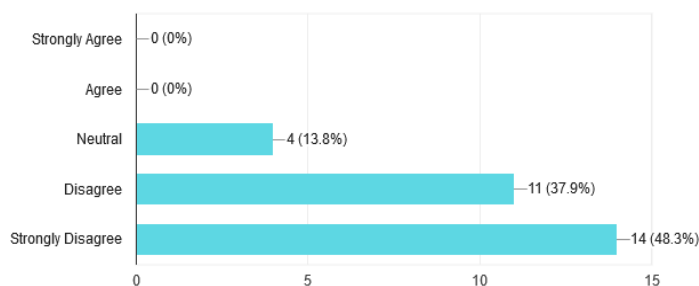- Question 2. Students like to read textbooks. The findings are shown in Figure 6.

Figure 6. The finding shows that students lost their interests in traditional textbooks and also lost their passion in reading traditional textbooks. Reading is very important for students, so if traditional textbooks are not able to attract students attention, capability of reading will decrease.

- Question 3. Normally each family member has a smartphone. The findings are shown in Figure 7.
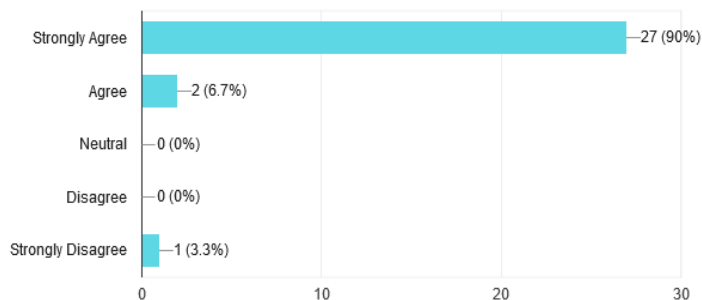

Figure 7. The finding shows that even students in a family have a smart phone which will facilitate the usage of AR book. AR is safe, user friendly, and can be used by students without supervision.

- Question 4. Using learning aids such as charts, pictures and posters of an animal can be similar to actual one. The findings are shown in Figure 8.
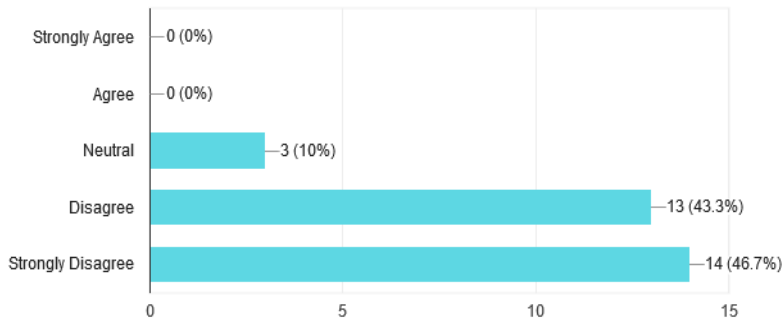

Figure 8. The finding shows that traditional learning aids have less efficiency in learning which causes the child to lose her/his interests and excitement. Charts, graphs, and posters are outdated.

- Question 5. In a learning process, seeing a real model of an object is efficient. The findings are shown in Figure 9.
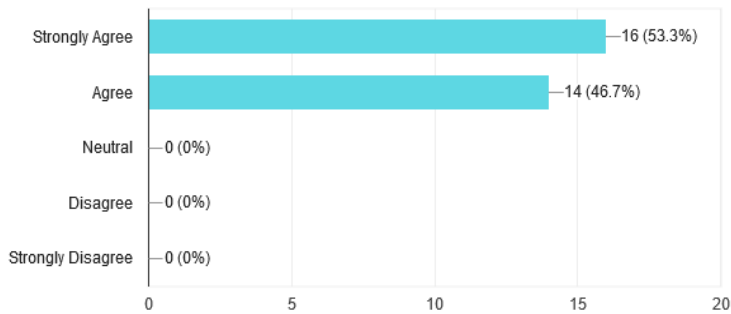

Figure 9. This figure shows that using 3D model has better impact and more helpful in the learning process. 3D models allow users to learn bereft concepts through interaction with tangible objects.

- Question 6. Usually, students use the cell phones for games. The findings are shown in Figure 10.
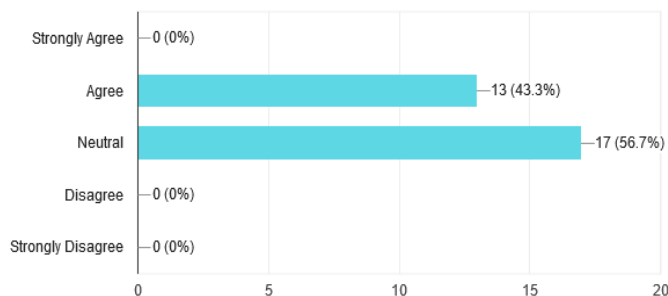

Figure 10. The figure shows the percentage that mostly students use their smart phones to play games and consume their golden age time unbeneficial.

- Question 7. Using AR textbooks for students have more benefits such as creativity and better understanding of concepts. The findings are shown in Figure 11.
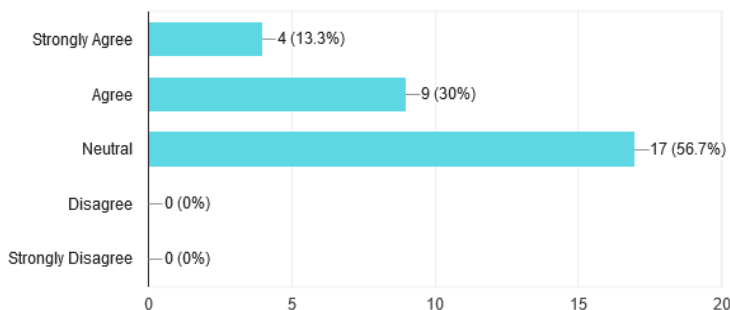

Figure 11. This figure shows that the percentage is neutral which tells that most people have no or very shallow idea about the advantages of using AR.

- Question 8. After showing a demo of AR book to the kids, AR books are major transformation of education. The findings are shown in Figure 12.
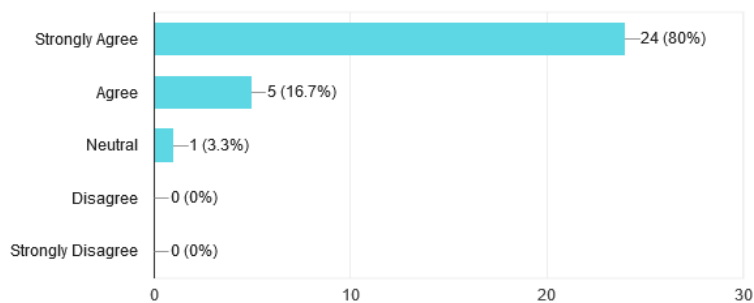

Figure 12. The figure shows that 29 out of 30 participants strongly agreed on the effectiveness of AR textbooks as educational and entertainment way of learning for an individual.

- Question 9. AR book can effectively ease learning for the students. The findings are shown in Figure 13.
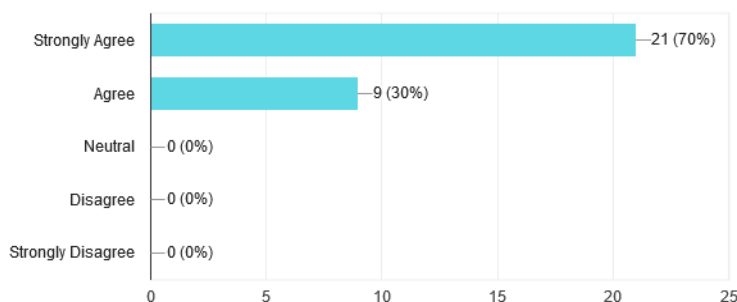

Figure 13. The figure shows that by observing augmented objects, the students will get better under-standing of the concepts they are reading. AR train's physical ability by focusing on creativity.

- Question 10. Use of AR books increase the desire to learn and be passionate about reading. The findings are shown in Figure 14.
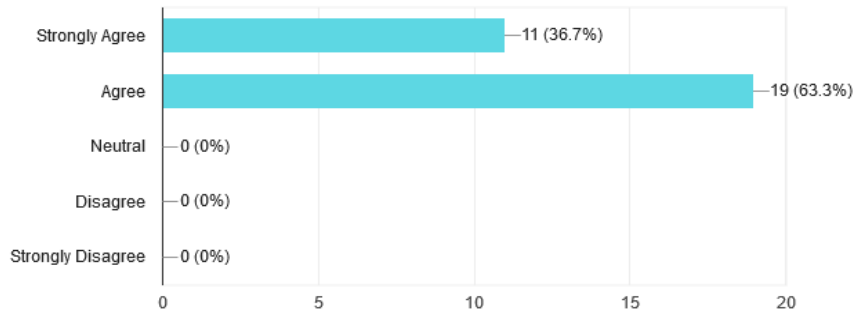

Figure 14. This figure shows that 30 out of 30 agreed and strongly agreed on AR textbooks are more exciting and more interesting to read. AR allow students to feed their intellectual curiosity, AR feds the hunger of students and students to discover their passions

- Question 11. Students mostly like the animals. The findings are shown in Figure 15.

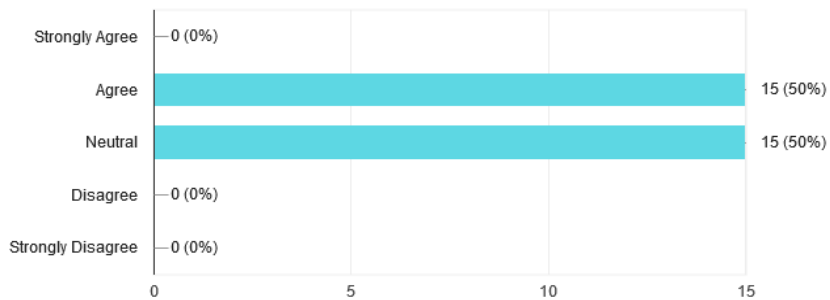Figure 15. This question shows that 15 participants answered neutral and 15 of them agreed on fact that the students have interest in animals.

- Question 12. The students do not have good knowledge about the ocean animals. The findings are shown in Figure 16.
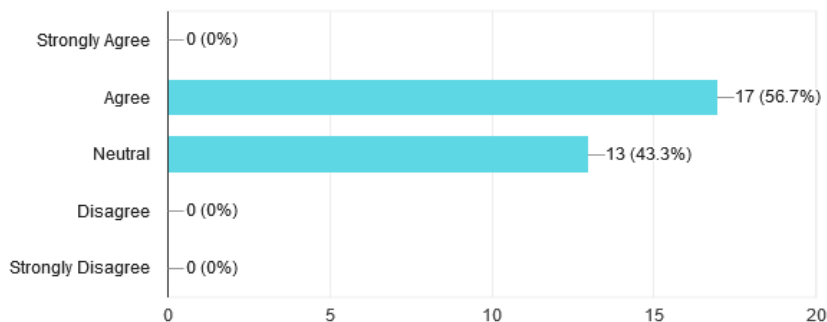

Figure 16. The figure shows that 17 of the participants agreed on having good knowledge and 13 of them have less or no knowledge about ocean animals.

- Question 13. The students will be able to learn about the ocean animals through the book with the AR application efficiently. The findings are shown in Figure 17.
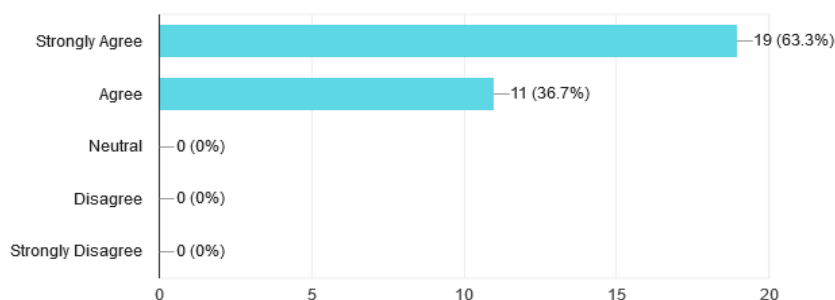

Figure 17. This figure above shows that all the participants agreed on the usage of AR textbook and its application. It shows an "idealized" models and shapes, without the parents and teachers having to spend hundreds of dollars on real prototypes for each child or student

Observation study

The evaluation collected through observation study was divided into two parts using the traditional textbook vs. reality augmented textbook, AROS. The study participants included 15 students at Al-Huda elementary school. Table 2 summarizes the findings for six observation items that covers student interaction, behavior, class environment including the teaching aids.

Table 2
Analysis over observation on textbook learning vs. AR book learning.

No	Observation Items	Textbook Learning	AROS Learning
1	How many kids interacting with the teacher?	The number of kids which interacting continuously and keeping up with the lesson is 5 out of 15. Most of the kids are feeling bored and some them feeling sleepy in the class.	6 out of 15 the number of kids interacting with their teacher. The rest of them lost their interest after 5 minutes from stating the class.
2	How many kids forgot their textbook?	4 out of 15 kids that forgot their textbook.	5 out of 15 kids forgot to bring their textbooks to school and they are sharing their friend's one.
3	Do kids interact effectively with	Mostly the kids in the class feeling lazy and some of the answers	Only 2 to 3 kids are interacting effectively with the teacher and

	their teacher?	given by them are incorrect.	the rest of them sitting silently or making noises to avoid listening to the teacher.
4	How does the class environment look like?	The class environment is quiet, and the kids are not interesting with anything in the textbook. Kids are interrupting the class by talking in different subjects with the teacher and with their classmates.	The class environment is very noisy, and some kids brought their phone along to school and they are playing with them and share that with their friends which makes very noisy.
5	How often the teacher should repeat a question?	As the kids are not always interacting with the teacher nor even interesting with the information in the textbook.	The teacher should repeat the question around 5 to 6 times to grab student's attention.
6	What type of books and teaching aids are there?	Traditional textbooks which kids are using to study from and teachers are using charts and graph as teaching aids.	Traditional textbooks have been used by students for studying. Flashcards and graphs have been used as teaching aids in the classroom.

Observation provides the ability of better judgment on a special case. In the beginning of the observations, only a little number of students or students are keeping their attention with what the teacher is explaining inside the classroom. Most of the students are not engaging nor interacting effectively with the teacher when taught using a traditional textbook. Without students interest, the classroom environment become very uncomfortable and difficult for the teachers to get students attention. With the traditional textbook, the teaching aids used in the class included flashcards, graphs, and flipcharts. On the other hand, an AR application when used along a printed book or even textbook will effectively aid the teaching process and make the learning environment more interesting and engaging. Augmented reality education books has become popular this last 2 years as students are all stuck in their homes with this AROS application students can still learning with excitement in their own home with their family and parents. Teachers also could use this book as online tool to assist their application in a 3D feel.

Conclusion

Augmented Reality of Ocean's Secret (AROS) is an interactive reading book augmented with animated objects and video playback. This book provides an

exciting narrative interspersed with range of reading genres along with entertainment to enhance students reading ability. Interactive learning books that offer 3D models are interesting to students due to its entertainment method of presentation that facts can be delivered in a more comprehensible manner. Evaluation of AROS has shown that interactive learning experience is interesting and enjoyable with easy navigation to move back and forth the content. It definitely enriches the learning experience by integrating virtual 3D objects to enhance understanding (Mubin et al., 2020). The Augmented Reality (AR) application is hoped to develop reading habit among students for both pleasure and information. Learning will become a positive and entertaining activity. Mundane lessons can be innovated to include games and music. Students have no more hard and boring class lectures. In addition, AR applications provide a more relaxed learning environment that is not time-bound. In the future, AROS can be expanded by putting in more augmented objects available from the physical book. More augmented objects will provide more information to the physical book that will enrich user knowledge and learning experience.

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