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TreasAR Quiz: Hunting Educational Treasures

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Abstract— This study proposes an AR model which can provide primary and secondary school students with an engaging environment to interact with scientific theories and objects which are obsolete from their day-to-day life. When young students are familiarized with concepts that have little relevance in their day-to-day life, there are chances that some of them may dismiss those concepts without realizing their significance. This AR models attempts to tackle this problem by capturing their attention and curiosity in a treasure hunt game where a scientific question about a scientific object is provided to them as a clue to find the treasure. The treasure is the scientific object itself. After they reach the correct entity, they have to answer a question related to the scientific object before getting assessed about the next object in the treasure hunt path.

Keywords— Augmented reality, WebAR, Marker-based AR, Image targets.

I. INTRODUCTION

Augmented Reality is a technology that enhances and augments natural feedback by merging virtual elements with reality. It fulfills some basic characteristics: blend of physical and virtual world, live interaction, and precise 3-dimensional alignment of virtual and real elements. This technology helps learners elaborate spatial arrangements and intangible ideas. The utilization of AR allows learners to explore scientific phenomena beyond the confines of physical reality. The sense of realism provided by AR promotes learners understanding of complex systems. The utilization of AR environments could stimulate learners' enthusiasm and curiosity, potentially resulting in the refinement of their investigative abilities and the attainment of more precise knowledge regarding the subject [1].

The pedagogical enrichment of learning content with AR provides engagement to teach the children with special needs by sparking their interest and attention [2].

AR is today used for a plethora of services like participatory design modules such as the Bowery wall where AR is used to restore the memories of a historical artwork allowing users to take a journey to see the original resemblance of the original artwork. Camden Alive is another example of an arts and culture platform where AR is used to appreciate thoughts, ideas and feelings of the diverse dwellers of the area. Similarly, City Unseen provides artistic AR experiences to the city and showcases the art of prominent artists alongside rebuilding dilapidated murals. Such examples show promise in visualizing the unseen with the help of AR and to provide a meaningful experience [3].

AR has applicability in different fields of education, different educational settings and at different levels of education. At present, we have game engines, Software Development Kits (SDKs), and libraries as easy and efficient methods to develop AR applications. This coupled with the ubiquitous mobile devices makes AR one of the most relevant technologies to be used in education. It is crucial here to emphasize that the success of an AR application does not solely depend on technical factors but also on the pedagogical aspects of its usage context. Tailoring each application to address the requirements and inclinations of users within the educational setting is paramount [4].

The idea behind designing AR educational games is to use game mechanics such as competition, rewards and curiosity to engage learners and simulate their desire to learn. A treasure hunt game in this context can have enhanced benefits when combined with a quiz module. Immediate and constructive feedback in such cases brings pedagogical benefits. Game rewards and incremental benefits motivate learners to keep playing and complete the game with learning gains [5]. However, few teachers apply such methods in actual classes due to the curricula being overloaded and there being a lack of resources. Consequently, students end up having only a surface level understanding in many fields. Such technological interventions could facilitate the much needed shift towards active learning that can facilitate a deeper understanding of theory and principles [6].

An AR quiz application can have various modes of interaction based on touch, voice, input field, gaze and gesture. It assesses the learners' learning activities whilst enhancing the features of assessment materials. Thus, AR technology is efficient for evaluation of learning activities as it meets the procedural requirements [7].

II. LITERATURE REVIEW

Research related to an augmented reality quiz implementation using object tracking has been carried out. The quizzes are reality based and three methods of visualization have been proposed. Single or multiple objects are tracked using SLAM algorithm to create the quiz model [8].

Quiz Cube is an example of an augmented reality quiz platform which superimposes AR images on AR codes and scanning a QR code leads to a website with quiz questions. The interaction takes place with the help of a fiducial marker cube [9].

Hunting Game Generator allows teachers to generate augmented reality environments that can be accessed by learners. The learners attend a lecture before looking at some hints or a location-based service to find certain characters. Thereafter, they have to answer the aforementioned lecture-related questions to collect rewards [10].

MeteorologyAR is a mobile augmented reality app which counters the passiveness of a large meteorology lecture class for the students by using interactive in-class, cloud identification game and personal take home AR modules. It displays meteorological features with related text [11].

The AHA project addresses the reading and spelling difficulties in children with ADHD by integrating AR objects in the WordsWorthLearning© (WWL) Programme. This program provides children with a seven-level learning module embedded with questionnaires to enhance their language skills. The integration of AR is aimed at stimulating their pupils' attention [12].

TreasAR Hunt is a mobile application that uses augmented reality and location-based services to provide users with a treasure hunt game where they go to different target locations to collect treasures and increase their scores [13].

An application for teaching primary school students about three-dimensional geometry has been made. There are limitations in teaching three-dimensional geometry on whiteboards hence AR is used to visualize these objects along with their areas and volumes to aid the understanding of students [14].

A residential fireground survival system was developed using AR which gave an interactive learning environment to experience and act on different fireground scenarios. It was found that the realism provided by AR positively impacts motivation and attitude. It was also found that a Tangible user interface such as that provided by AR decreases cognitive load thereby making cognitive learning easier [15].

TABLE I. SURVEY TABLE

Reference	Year	Research Gaps	Features	Techniques
[8]	2015	• An AR quiz game without the need of the presence of the object to be quizzed in the real world.	Object tracking and displaying the questions related to the tracked objects, clicking on the tracked objects as answers.	SLAM algorithm, markerless tracking, Metaio, HTML, virtual buttons
[9]	2016	• The standardization of the AR quiz for every student with pre-fed questions. • The question being assissted with an AR object.	Choosing the quiz, 3D model for the quiz questions, rotating the fiducial marker cube for choosing the correct answer, checking scores.	Fiducial marker cubes, Web Technology, Quick Response Code (QR), Alvar, HTML5, Javascript
[10]	2018	•The AR objects may be made more interactive. •They may be directly linked to the question.	Allows users to analyze clues, catch the target and answer subsequent questions.	GPS, Angular 4, Ionic 3, Cordova, Wikitude Javascript API
[11]	2020	•The visualization of the AR object needs to be the appropriate resolution so that the picture is understood.	Visualizing the 3D AR model on classroom board.	Unity, Vuforia, computer vision algorithms, Blender modelling software.
[12]	2020	•The quiz questions may be aided with augmented reality objects for better depiction of the question.	Providing multiple choice questionnaire for language modules, displaying learning content in the form of AR objects.	Three.JS, AR.js, WordsWorthLearning© (WWL) Programme
[13]	2021	•The interaction with the AR object in the form of a quiz is a valid use.	Registration and authenticationof users, hints for identifying the targets, revealing the target location, recognising the target and collecting treasure.	Marker-based detection, Location tracking, Unity 3D, Vuforia, Adobe Photoshop
[14]	2023	•The AR objects may be integrated as part of the quiz.	View of geometrical AR image with the help of marker, quizing on a geometrical shape with timer, viewing scores.	Linear Congruentia Generator (LCG), Fuzzy Tsukamoto methods, Unity, C#, Adobe Illustrator, Blender software

III. ETHODOLOGY

This study engages the learners with the learning content in two steps. The first step is to identify the scientific object with the help of a clue provided regarding it. This is the treasure hunt aspect of the model. The second step is for the learners to answer a question based on the object to continue this game with the other objects. This is the quiz aspect of the model. The learning assessment is twofold in this model: the first time when the learners uncover clues about the object and the next time when they solve the quiz related to the object.

A. Treasure Hunt

In this part of the game, a statement referring to the object is displayed on the game screen as a clue for the players to see. If the players understand this clue displayed on the screen, then they can find the object and scan its picture that is present in the physical learning environment. The picture acts as an image target for the 3-dimensional AR model and the quiz question of the object. For example, if the learning activity is targeting the planets in the solar system, the players will have to scan the planet which is correct according to the clue. This model works best when the entire assessment is done on objects of the same category.

B. Quiz

The purpose of the quiz is to test the players additional knowledge regarding the object. The quiz question of an object is displayed alongside the object and the students interact with it using virtual buttons. The virtual questions in this model are in the form of 2-dimensional AR objects. The quiz could consist of one of the following formats:

- The questions could be in a multiple-choice format where players have to choose the correct option from multiple choices.
- The questions can have a fill in the blanks format where players manually type-in their answers.
- The quiz can also consist of questions that require answering by different or multiple methods.

The quiz tells the learners if their answer is correct by allowing them access to the next clue. Answering the questions with the object displayed alongside it would help in developing associations between the object and the learning material.

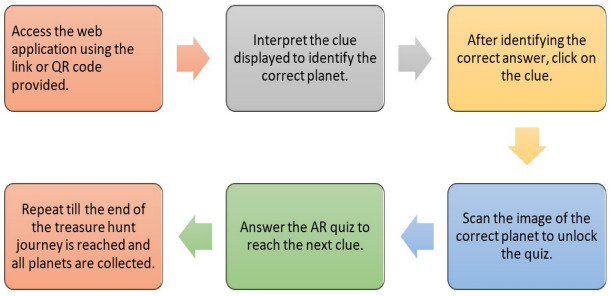

Fig. 1. Steps in the player journey.

A working prototype of the proposed methodology for edutainment was developed using PlugXR. PlugXR is a no-code platform that has an extensive set of features to create fully developed experiences in Augmented Reality, Virtual Reality, Mixed Reality and Metaverse. Planets in our Solar System were chosen as the subject on which the learners will be quizzed. Thereafter, questions and clues were developed based on the primary information about all the planets. The clues were added in the PlugXR project as a button and the quiz questions were linked to them. The correct answer of the quiz was similarly linked to the next clue. 3-dimensional .glb object files were created for all the planets using the 3D models of the planets publicly available through nasa.science.gov. These 3-dimensional models were added to the quiz pages. The AR web application was published after completing the aforementioned steps and was ready to use.

IV. RESULTS

A user testing was conducted on a class of eighty-four students aged between 17-22 years and the performance of the application was observed. Given below are the different interfaces running in the application captured during user-testing.

Fig. 2. Welcome screen with initial clue.

First clue of the treasure hunt is displayed on the welcome screen. The players initially scan the image marker of the Solar System to get the first clue. It is preceded by the welcome message, “Let’s hunt some treasures. Find the PLANET:”. The clue states, “This planet has the most moons in our Solar System.” It prompts the players to find and scan the image target in their environment of the planet Saturn. Scanning the image target of Saturn will lead to a quiz-question about it and answering it would lead to a clue about another planet, Mars. All the clues are 2-dimensional AR buttons and lead to the scanner for the image target when they are clicked.

Fig. 3. Clue for Mars.

The given image is displayed when the students answer the quiz-question of Saturn correctly. This is a clue which prompts them to find and scan the image target of the planet Mars. The clue states, “This planet is also known as The Red Planet.”

Fig. 4. Quiz-question for Mars.

This is the quiz-question for Mars. A rotating 3-dimensional
AR object of Mars is displayed alongside it. The question states, “Mars has the largest volcano in the Solar System. What is it called?”. It has options as “Olympus Mons”, “Mauna Loa”, “Mount Fuji” and “Mount Etna”. “Olympus Mons” is the correct answer. Clicking on it leads to the clue for the next planet and the same process is continued for all other planets in the Solar System.

Fig. 5. Clue for the Earth.

This is the last clue in the treasure hunt path hinting at the planet Earth. The clue states, “It is our home and the largest terrestrial planet.” Scanning the image target of the Earth will lead to its quiz-question.

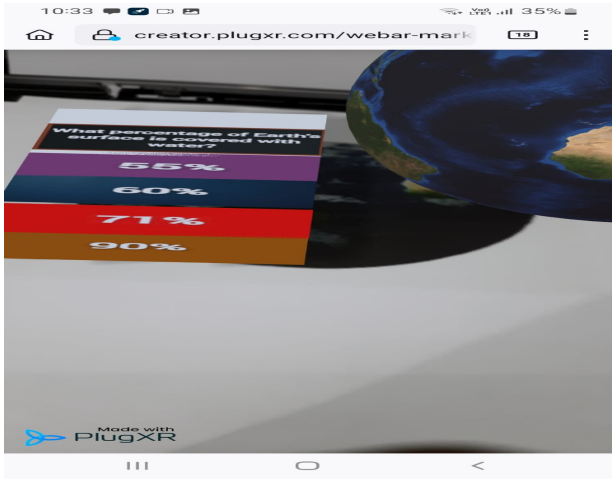

Fig. 6. Quiz-question for Earth.

The screen presents the final quiz question. It has a rotating 3-dimensional AR object of the Earth displayed alongside it. The question states, “What percentage of Earth’s surface is covered with water?” with options as “55%”, “60%”, “71%” and “90%”. “71%” is the correct answer. It leads to the final screen of the game.

Fig. 7. Final screen.

This screen indicates that the players have completed the treasure hunt journey with the message as, “You have now hunted all the planets on this adventure. Good job!!!”

The responses of the users during user-testing were self-attested and were recorded in a form. They were asked to rate the features that were relevent to the goal of this paper on a scale of 0-5. The results are presented here in the form of a table. The table consists of the average rating provided by the test group. This is compared with the testing results of the aforementioned papers.

TABLE II. RESULTS OF USER-TESTING

Parameters	Rating
Interest in the Solar System before using the application	3.124
Interest in the Solar System immediately after using the application	4.643
Engagement provided by the game	4.762
Gain of knowledge	4.762
Attention	4.416

The level of "attention" rated by the test-group is 4.416 as compared to 4.124 in ref. 15. The other factors solely assessed in this paper solidify the hypothesis of AR being benefecial in providing learning gains and evaluating the learners. The rating of 4.762 in "gain of knowledge" is consistent with the teachers' suggested answers in ref. 7 with the 25 teachers suggesting the use of AR in "formation of knowledge" phase of learning. The 36 teachers also support the use of AR in "evaluation of knowledge, skills and abilities (learning activities)" that is consistent with this study. The "engagement provided by the game" is rated to be 4.762 and there is a significant increase shown in the "interest in the Solar System" from before using the game to immediately after using the game. The game is shown to be engaging the learners in the learning material.

The prototype is found to be successfully running through all phases of execution. The game in intentioned to be played for 7-10 iterations of clues. This is expected to provide a satisfying play experience with ample learning gains. This model provides teachers with a learning resource catered to primary and secondary school students to assess the subject matter and consolidate their learning gains. Such games are expected to be integrated in the learning pedagogy of schools in the near future in order to take advantage of the ubiquitous nature of smart devices and and the increasing interest of students in digital devices.

V. CONCLUSION AND FUTURE SCOPE

This format of learning encourages the learners to introspect on their knowledge. The immediate feedback helps them in clearing their misconceptions. The learners are invested in the scientific entities which may not interest them in a normal setting. The game is hosted on the web and does not require the learners to download an application and can be readily facilitated by using a link. This model caters to the need of an AR application to fuel the scientific curiosity in young children and provide them with and insightful view into the world of science by effective visualization of scientific objects.

This model could be extended to visualize complex scientific phenomena along with related questions for learners at various educational levels. The treasure hunt module could also be used with location tracking instead of image tracking which is more suitable for outdoor learning rather that in-classroom learning. Quizzes regarding different scientific objects like bio-elements and geographical features could also be held using this model.

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