

FOCAL: An Android Scanner of Periodic Table of Elements

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Abstract: The purpose of this study was to develop an E-learning android application that would allow users to read Periodic Table Elements using Augmented Reality Technology. The study focused on the integration of Information and Communication Technology (ICT) in an interesting and interactive way of learning. FOCAL was created using the following applications: Unity for developing the application, Windows 3D Builder and Blender for 3D modeling, Vuforia for augmenting objects and scanning, Adobe Photoshop CC for designing graphics and periodic elements, Maya and C# for the back end. The application was tested using the following tools: the functionality test to ensure that all the modules of the application were responding as they were designed to do; the compatibility test to ensure that the application runs well on all android platforms and the conformance test to ensure that the application abides by all software development standards. Using the Rating Scale (MARS), the application was evaluated by ten (10) IT experts, fifteen (15) Students taking Chemistry Subjects and fifteen (15) Android-Users; all of whom rated it as highly acceptable.

Keywords: Augmented Reality, Periodic Table of Elements, Chemistry, 3D Modelling, Interactive Learning.

I. INTRODUCTION

Today, we cannot imagine education without innovative technologies that make the learning and teaching process easier. For example, Internet technologies give students instant access to any information and allow them to collaborate with other students in different projects.

Not many researches have been conducted about the merits of Augmented Reality (AR) but it has been pointed out that Augmented Reality can make learning more engaging and affordable while creating an authentic learning environment for students [1], [2]. Augmented Reality is a growing field of technology where reality is modified and enhanced by sights and sounds generated by a computer. AR makes the existing reality more meaningful because it allows interacting with it. Augmented reality has a great potential to be used in the classroom because it changes the way students interact with the real world, enhances student engagement, and makes the learning of their subject content a fun. When incorporated into education, AR motivates students to explore and, in this way, learn. It expands the student's horizons and fosters their creativity and imagination.

Typically, AR can be viewed through mobile apps that turn monotonous lessons into interactive games. If you point a camera of your mobile device at something that the application recognizes, it will produce a video or a 3D animation over the things that are on your camera screen. It is great that a computer-generated object looks real and makes learning more engaging. This technology opens a whole world of new learning opportunities for students, helping them understand complex concepts and have fun. [3]

A. Objectives of the Study

The general objective of the project is to develop “FOCAL: An Android Scanner of Periodic Table of Elements”.

Specifically, the project aimed to:

1. Design an app consisting of the following features:
 - a. A display with extended information about the periodic tables, showing examples of elements and their attributes.
 - b. A 3 dimensional (3D) format of elements.

- c. Trivia questions to test the knowledge of the users about periodic table elements.
 - d. Periodic Table Elements characterized according to their composition.
 - e. A calculator for the computation of the molecular mass of a certain element.
 - f. An automatic voice narration of elements.
2. Create an application using tools such as Unity for developing the application, Windows 3D Builder and Blender for 3D modeling, *Vuforia* for augmenting objects and scanning, Adobe Photoshop CC for designing graphics and periodic elements, Maya and C# for the back end.
 3. Test and improve the application using the functionality, compatibility, and conformance test tools.
 4. Evaluate the acceptability of the mobile app using the Mobile Application Rating Scale (MARS).

B. Scope and Limitation

The system currently runs on Android operating system only: it works well on Android smartphones with Android 7.0 Nougat up to Android P version 9 platforms. It is recommended that the Android smartphone has a minimum of eight (8) megapixels and has to be directly aimed at the element of interest at approximately 15 cm away in a well-lit area. However, the image that will be displayed will still depend on the size of the device's lens. The application has an auto-focus.

C. Significance of the Study

This E-learning android application, FOCAL will be beneficial for the following entities:

Students. When incorporated into education, AR motivates students to explore and, in this way, learn. It expands the student's horizons and fosters their creativity and imagination. [4]

Teachers. For the Science Teacher, this study will help to deliver an alternative way of teaching Chemistry subjects particularly the Periodic Table of Elements.

Future Researcher. This study can serve as a reference for future researches that will be conducted about computer-aided learning

II. METHODOLOGY

This chapter introduces the design, development, testing and evaluation procedures performed in the realization of the research project.

A. Design

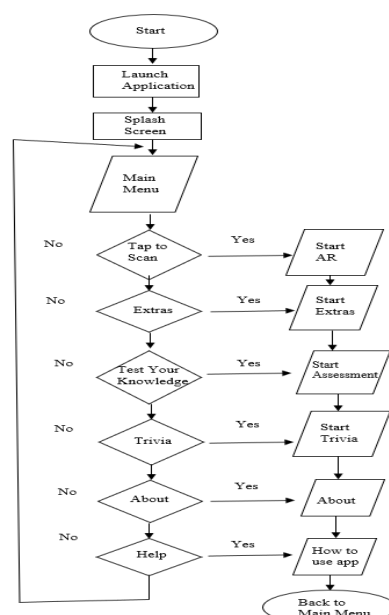


Fig. 1: Program Flowchart

Figure 1 is the Program Flowchart representing the sequence of operation of the project. This diagram only shows what the application does when executed. Once the application is launched, it will show the splash screen and then the different option from the main menu. The user can choose from different option such as Tap to Scan, to start learning about the elements in the periodic table using augmented reality.

B. Development

This section discusses the software and hardware requirements in the creation of the application.

Software specification. The researchers used Android Operating System (Android 7.0 Nougat up to the latest version 8.0 Ore) as the main platform in creating the FOCAL Application, Adobe Photoshop CS6 for photo graphics, Blender 2.77 for creating the background and animations, Vuforia for the augmented reality and Unity for coding.

Hardware specification. A Desktop Computer with Intel Core i7, 70GH was used to create the application. Android smartphone Galaxy S9 with 2GB RAM Snapdragon 801and Quad core 2.5GH were used to test the application.

C. Test Plan

This section discusses the methods and procedures used to identify problems and improve the quality of the software.

The application was tested using the following tools: the functionality test to ensure that all the modules of the application were responding as they were designed to do; the compatibility test to ensure that the application runs well on all android platforms and the conformance test to ensure that the application abides by all software development standards

D. Evaluation Plan

The evaluation was performed to validate the users' acceptability of the application.

Different models of smartphones and different Android versions were used in the evaluation process. Using the Mobile Application Rating Scale (MARS) based on the criteria of functionality, Engagement, and Aesthetics, the application was evaluated by ten (10) IT experts, fifteen (15) Students taking Chemistry Subjects and fifteen (15) Android-Users; all of whom rated it as highly acceptable.

III. RESULTS AND DISCUSSION

A. User Interface and Design

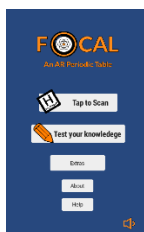


Fig. 2: The Main Menu

Figure 2 shows the main menu display of the project. It consists of 5 main function buttons: the Tap to Scan button for scanning an element to show 3D representations, Test your knowledge button to experience True or False trivia questions, Extra button to experience other activities and the About and Help buttons for credits and assistance on how to use the application.

B. Test Results

TABLE 1: SUMMARIZED RESULT OF COMPATIBILITY, CONFORMANCE, AND FUNCTIONAL TESTING

| System Testing | Pass | Fail | Total number of test condition | Percentage |
|-----------------------|------|------|--------------------------------|------------|
| Compatibility Testing | 5 | 2 | 7 | 71% |
| Conformance Testing | 20 | 0 | 20 | 100% |
| Functional Testing | 16 | 16 | 16 | 100% |

The summarized test results of FOCAL conducted based Compatibility, Conformance and Functional testing are shown in table 1. In compatibility testing, the application is tested on Android OS starting from Android 7.0 (Nougat) to Android 8.0 (Oreo) using different smartphones. At 71%, the testing got a score of “5” out of “7” with 71%. This was because the system was not tested on the newest versions of Android namely pie. The conformance testing uses the standards of the Android Core App Quality. At 100% the app got a “20” out of “20”. In the functional testing, the app got a score of “16” out of “16” with a percentage of 100.

C. Evaluation Results

TABLE 2: OVERALL EVALUATION RESULTS

| Level of System Acceptability | Mean | Standard Deviation | Interpretation | Rank |
|-------------------------------|------|--------------------|-------------------|------|
| Engagement | 3.9 | 0.32 | Highly Acceptable | 3 |
| Functionality | 3.93 | 0.28 | Highly Acceptable | 2 |
| Aesthetics | 3.89 | 0.33 | Highly Acceptable | 4 |
| Information | 3.95 | 0.24 | Highly Acceptable | 1 |
| Average Mean and SD | 3.92 | 0.03 | Highly Acceptable | |

The total respondents were 35 including ten (10) IT experts, fifteen (15) Chemistry Students, and ten (10) Android-user.

At a Standard Deviation (SD) of 0.33, the highest rank in the overall evaluation results was the “Aesthetics” criterion. The majority of the respondents strongly agreed that the application had a good design. At a Standard Deviation (SD) of 0.32, the second in rank was the “Engagement” criterion. The respondents strongly agreed that the application was fun and interesting to use. The third in the ranking was the “Functionality” criterion. The respondents strongly agreed that the application responded the way it was designed to do. Lastly, at a Standard Deviation of 0.24, though the “Information” criterion ranked last, it was still interpreted as “Highly Acceptable”. The respondents strongly agreed that the application content and visual explanation of concepts were appropriate and sufficient for the targeted users.

IV. CONCLUSION AND RECOMMENDATIONS

A. Conclusion

The developers successfully created a mobile application named FOCAL: An Android AR Scanner of Periodic Table Elements for students who are taking chemistry subject. The application was designed with the following features: a display with extended information about the periodic table; a 3 dimension (3D) format of elements, a Test the knowledge button for the users to experience the trivia questions; a calculator for the computation of the molecular mass of a certain elements; and an automatic voice narration of elements. The application was created using the following tool: Unity for developing the application, Windows 3D Builder and Blender for 3D modeling, Vuforia for augmenting objects and scanning, Adobe Photoshop CC for designing graphics and periodic elements, Maya and C# for the back end. The project was tested and improved based on the functional, conformance and compatibility test. The evaluation was conducted to achieve the system's acceptance to the user based on the Mobile Application Rating Scale (MARS). The overall result got a mean of "3.92" and an average standard deviation of "0.29" that was interpreted as “Highly Acceptable”

B. Recommendation

Based on the findings and conclusion presented, the following recommendations are made for the future feature enhancement of the project:

1. iOS platform compatibility for the flexibility of the application.
2. Adding more trivia questions about the periodic table.
3. Handwritten elements recognition.

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