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Arsci: An Augmented Reality Learning Media for Science and Technology

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ABSTRACT

This capstone project is the design, development and implementation of ARSCI: An Augmented Reality Learning Media in Science and Technology, which is designed specifically to be used by Grade VI students of Lagao Central Elementary School in General Santos City. The system provides a new system where a combination of interactive 3D models, augmented overlays, and embedded quizzes is introduced in a mobile application so that a student can visualize abstract concepts in science in an interactive and easily accessible way. The teacher-based application was also developed as a web-based application to aid in content management and monitoring student progress. ARSCI was developed through the support of the Agile approach and Unity, Vuforia, React.js, and AWS to address the limitations of the conventional way of instruction and enhance visualization, promote blended learning, and self-directed learning. To teachers, it is an additional teaching aid that enhances productivity and power in lesson delivery. Finally, ARSCI serves to enhance and make the learning process more interactive and efficient, as well as has a potential to develop into other subjects.

INTRODUCTION

The study of Gamboa-Ramos *et al.*, (2021) states that the application of technology in education can accelerate learning among students with the help of tools to enhance the abstractions along with elaborate ideas that from traditional means and materials, such as textbooks and lectures, are hard to assimilate into the minds. The purpose of integrating augmented reality into learning processes is to improve self-directed study and allow collaboration such peer-to-peer learning. The blending of the qualities of reality with the digital information perceived by students on the screens of their mobile phone forms much of the very basis of the development of an Augmented Reality-based mobile application (Basumatary & Maity, 2023). The current scenario of science education at Lagao Central Elementary School gives space for the Augmented Reality improving opportunity. The graph carried out through the blended learning approach that the school has adopted is well thought out, yet this approach will not give the rich and three-dimensional aspect of the types of elements that Augmented Reality avails a user to. This project is focused on exploring the current advancement of the technologies of Augmented Reality to develop the ways of giving a significantly better learning experience to the Grade VI students of the Lagao Central Elementary School in the Science and Technology subject. The Augmented Reality mobile application will afford visualization avenues and further knowledge on the respective science concepts. 3D interactive models would allow the students to view the objects from different angles, and augmented overlays would provide more information about their structure, functionality, and relevance. This includes having quizzes in the app to evaluate students' understanding toward further learning.

Augmented Reality Related Literature

Mystakidis *et al.*, (2021) address the practical challenges that the introduction of AR to the fields brings about. They highlight the varying level of technical knowledge in students that might influence the easy availability of AR and its ease of use. Although they emphasize that AR design should be inclusive and teachers should gain enough support to implement AR successfully, they also refer to the training and professional development as lacking which is discussed by teachers.

Khan *et al.*, provide empirical evidence of the positive effect of AR on the motivation of students to study. They especially study such aspects as attention, satisfaction, and confidence, and the application of an AR mobile app demonstrates significant gains in these motivational aspects. This highlights the ability of AR to establish an even more engaging and satisfying learning experience (Khan *et al.*, 2024).

It is also demonstrated by Chin and Wang (2023) that AR-based mobile touring systems are more effective at enabling students to remember as compared to traditional ones. Specifically, the positive impact on interest and task-based interest can justify the role of AR as a factor that helps to make learning more relatable and enjoyable in an outdoor setting. Such information makes AR more appealing to practical learning.

In addition, Yusa *et al.*, (2022) explain the flexibility of the AR-based mobile applications that can be used everywhere and any time. They also focus on such features as animations, games, and 2D/3D pictures to

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make students more motivated and enhance the learning outcomes especially in the areas where it is necessary to interact living organisms and the environment. This highlights the ability of AR as an easily accessible tool of self-directed learning.

Existing Augmented Reality Technologies

Mobile Application with Augmented Reality to enhance Learning in Science and Technology (ARST) was designed to assist in the learning of Science and Technology among primary school 6th grade students and 1st year secondary school student. The article identifies the ability of augmented reality to facilitate face-to-face and distance learning (Gamboa-Ramos *et al.*, 2021). The ARST application enhances the learning process through the application of the augmented reality system, thus incorporating the use of 3D models of food products and 3D-based tests to interact with students and evaluate their level of knowledge. ARST app was technically developed with the help of Mobile-D approach and such technologies as Unity, Blender, Vuforia, and Visual Studio were used. The AR experiences were built using Unity, Vuforia provided augmented reality capabilities, and Blender produced 3D visualizations. The study found that the ARST application raised students' level of interest in the topic, enhanced their understanding, and maintained a high degree of satisfaction. The outcomes of pre-test and post-test assessments showed the app's efficacy in improving learning results. The study included 30 students from one educational institution and concentrated on a particular subject food and its classification within science and technology. The study's sample size was rather small.

Like ARSCI, the ARST app aims to enhance science education by means of augmented reality in a mobile setting. Both initiatives interact with students and show ideas using augmented reality. ARSCI, on the other hand, is designed to meet the particular needs of Grade VI pupils at Lagao Central Elementary School and works with the blended learning model of the school. ARST concentrated on food and its categorization; ARSCI hopes to address a wider spectrum of scientific subjects under the Grade VI syllabus.

Taufik, Alamsyah, & Saputra (2023) created a mobile app based on augmented reality to help with knowledge of computer network hardware. This study tackles the problem of students finding computer network hardware material difficult to grasp because of boring learning and a lack of physical resources. Aiming to provide a more efficient and interesting learning environment, the built application uses augmented reality to offer visual representations of computer network hardware. The app was developed to be compatible with Android phones as the smartphone use is popular among students.

The application has been created with the help of Research and Development approach, and its impact on the learning outcomes has been determined with the help of the Independent Sample T Test. The results of the study indicated that the application of the augmented reality was a significant improvement in the outcome of the student learning. This highlights the potential of AR technology in enhancing learning of technical subjects using interactive and visual teaching aids. Though ARSCI is focused in science education of elementary children, this system demonstrates the more general application of augmented reality in education, particularly in technical fields such as computer networking.

MATERIALS AND METHODS

The study employed a developmental research design supported by descriptive-quantitative evaluation. System development followed the Agile Software Development Life Cycle, allowing iterative construction, testing, and refinement based on user feedback.

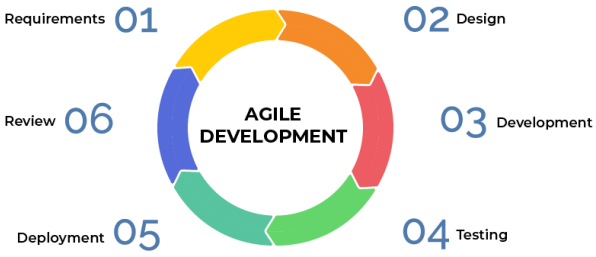

Figure 1: Agile Model of SDLC

The Agile Model of SDLC approach was applied in the development of ARSCI as shown in Figure 1. Agile was selected because it has several iterations, feedbacks, and constant improvement. The Agile methodology follows a structured sequence, starting with requirements, design, development, testing, deployment, and review. In ARSCI system, the dynamics in requirements and user necessities occurs in the entire development phase thus making agile methodology suitable for the software development lifecycle of ARSCI making it efficient and effective to the users involved.

Requirement Gathering

The researcher conducted an interview with the school principal and one of the teachers in Lagao Central Elementary School to gather all the necessary data and information about the current learning, teaching process, and curriculum. The project proposal for an interactive learning media came up after the interviews and thorough analyzation. The researchers then conceptualized the system that includes the business process, objectives, functions, system requirements, as well as the scope and limitations. After all the brainstorming and conceptualizing, the researchers had undergone to several consultations with the adviser to discuss the features and the ideas of the project.

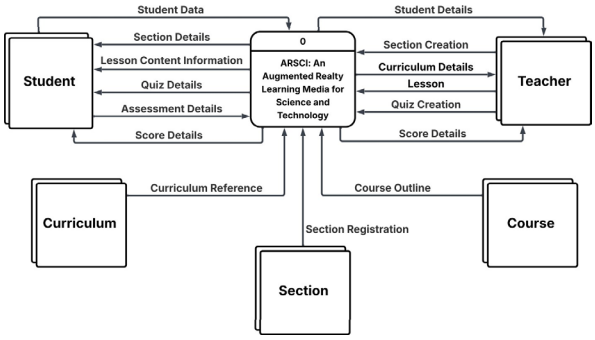

Figure 2: Context Diagram

The information flow and process logic of ARSCI system are described in a context diagram (see Figure 2) to facilitate the effective exchange of information.

Design the Requirement

Design the Requirement phase ensures that all specifications are met and prepares the system for development. The in-scope of this capstone study focused on developing an Augmented Reality Learning Media of Science and Technology:

In-Scope

1. Development of an Augmented Reality (AR)-based mobile application for Grade VI students.
2. Coverage of specific topic of Grade VI Science and Technology: Animals, Human Anatomy, Volcano, and Solar System.
3. Overlayed augmented 3D interactive models.
4. Built in quizzes in the mobile application to test and reiterate what one learns.
5. Web-based content control, user accounts management system and teacher monitoring of student progress.
6. Designed to support the school's blended learning method.

Out-Scope

1. iOS operating system device compatibility.
2. Functionality without a working internet connection for AR content and quizzes require online access.
3. Assured on all android devices the experience is also dependent on the type of camera and ability of the device.
4. The broadening of current Grade VI subjects teaching in terms of number of listed topics 0i0n terms of science.
5. Substitution of current teaching resources the app is yet not a replacement to the textbooks, videos or lectures.

Figure 3 shows the ARSCI website dashboard, the tool for monitoring student activity in the application. The teacher can monitor the student module progress and quiz scores.

Figure 4 illustrates the interface of ARSCI mobile application for students. The application enables students to access science and technology lessons represented

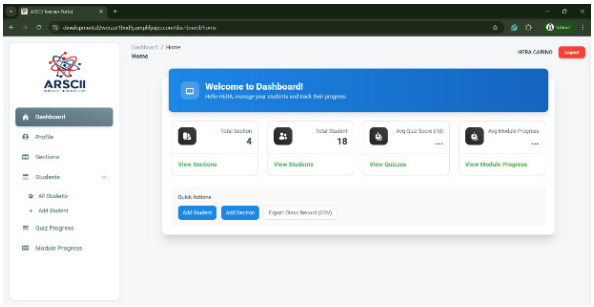

Figure 3: ARSCI Website Dashboard

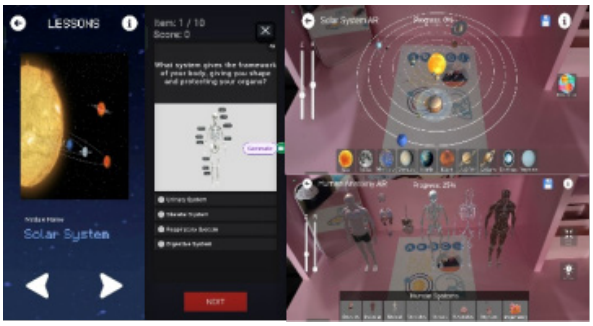

Figure 3: ARSCI Website Dashboard

using 3d models and 2d feature for the quiz part.

System Architecture shows how the ARSCI system works. It starts with the student mobile app, which shows an augmented reality environment on the device screen. This combines real-world camera views with virtual content that Unity manages and Vuforia tracks. When the student uses the app in a way that needs backend data or processing, the mobile app's HTTP Client makes a request over the internet to the API Gateway, which is the way into the app's backend on AWS. After that, the API Gateway sends the request to the right AWS Lambda function. These Lambda functions, which hold the main logic of the app, talk to the Amazon DynamoDB database to get or save data when it's needed. The API Gateway then sends the results of this interaction back to the mobile app's HTTP Client, which updates the user interface on the student's screen.

Teachers operate through a web interface that was developed with ReactJS and JavaScript. Both content management by the teacher and getting information from the web app use the HTTP Client to go through the API Gateway. AWS Lambda functions deal with these requests, consulting the DynamoDB database to help the teacher. The web application gets the responses back, which changes what the teacher sees. Amplify hosts the web application itself, which is made up of static files. This gives the teacher's interface a platform that can grow and is always available.

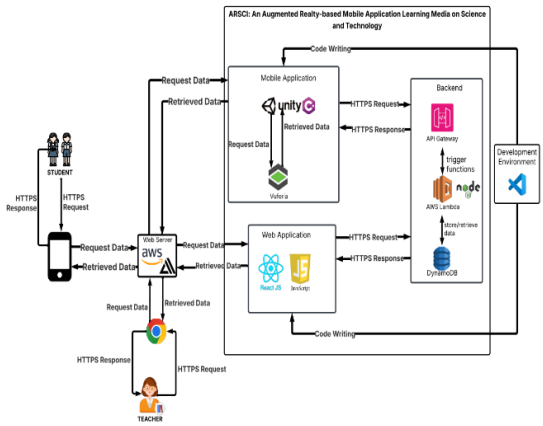

Figure 5: System Architecture

Development and Testing

During the Development phase is where the ARSCI system is constructed based on the design specifications. For the AR Mobile Application, this involves writing code in Unity using C# and integrating the Vuforia SDK to implement the AR functionality. 3D models and other assets are integrated into the application, and the user interface and quiz interactions are implemented. For the Web Application, this phase involves developing the front-end using React.js, HTML, CSS, and JavaScript, and building the backend logic using AWS Lambda with Node.js. The database (Amazon DynamoDB) is set up, and APIs are created to enable communication between the mobile application, web application, and the database. The result of this phase is a working version of the ARSCI system, ready for testing.

The testing phase analyzed the performance of the ARSCI system and confirmed it fulfills the demands that were stated. The checklist includes making sure the AR functions, user authentication is safe, quizzes function as expected and everything works for knowing your results. By testing, the Web Application, we confirm that users can manage themselves and view results as expected. Levels of testing include running tests on individual parts, testing several parts working at once and testing the full system as a whole. By fixing any issues at this phase, we can give users a flawless system.

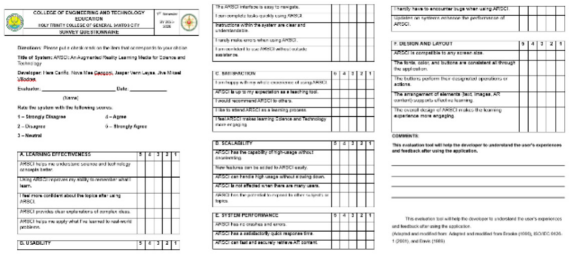

Figure 5: System Architecture

Deployment

Data Analysis Plan clarifies that the purpose of the study is to determine the effectiveness, the usability and the level of user satisfaction of the ARSCI system by analyzing the feedback that will be received during and after the implementation. It will be divided into the quantitative and qualitative data analysis to discover the patterns, insights, and areas that should be improved in order to increase the performance of the system and its usability in general.

The key parameters, which will be investigated, are the simplicity of use, the functionality of the AR features, the precision of quizzes, the system reliability, and overall user satisfaction. Feedback will be offered to the different categories of users, including Grade VI students and science teachers in order to have a better idea about their experience and their perspective. These aspects will be evaluated to confirm whether ARSCI system is capable of supporting the learning requirements of the people using it.

The main instrument of data collection will be structured surveys. The surveys will contain not only closed-ended questions that will be measured with the help of 5-point Likert scale but also open-ended questions to collect qualitative feedback. Particularly, the survey will provide information about:

1. User response to interface design, usability and system performance.
2. Recommendations of better improvement and feature enhancement.

The data set will be comprised of answers to students and teachers of Lagao Central Elementary School who will be selected at random. This is in the form of quantitative ratings of usability, reliability, system performance and overall acceptability and qualitative responses regarding user experiences and recommendations regarding the use of the ARSCI system.

The analysis will be done through calculation of the Weighted Arithmetic Mean (WAM) of the quantitative ratings and through identification of various important insights on qualitative feedbacks. The process will assist in determining the strengths and weaknesses of the system or the critical success factors of the system, as well as making practical suggestions on how ARSCI can be enhanced as a learning tool.

LITERATURE REVIEWS

In the Review phase, you look at the ARSCI system and the process used in development to see how they can be improved. For this reason, check how helpful the system was for users, see if the system reached its learning purpose and assess how well and how easily the system was operated. Team members go over the whole process to review what helped them, areas that need improvement and what they gained. The outcomes from the review phase are put to use as feedback, directing how ARSCI should improve for its users.

RESULTS AND DISCUSSION

In this chapter, the results of the assessment performed on ARSCI: An Augmented Reality Learning Media of Science and Technology are presented and the results of the evaluation are properly discussed with references to the aims of the study. The information was collected using survey questionnaires, usability tests and the comments of the targeted end users, Grade VI students and science teachers of Lagao Central Elementary School. Some of the key areas considered in the analysis tool learning effectiveness, usability, satisfaction, scalability, system performance, and design and layout are described that jointly indicate the quality of functionality and the shaping of education quality of ARSCI. The outcomes of the results indicate not only to what degree the system was able to meet or even surpass expectations but also what can be improved by enhancing the aspects that need refinements. The system aspects were rated on a five-point Likert scale by the respondents (Boone *et al.*, 2012). The following are the raw survey responses collected from 20 educators of Lagao Central Elementary School dated October 2-3, 2025. Each item was rated on a 5-point scale:

5 – Strongly Agree
4 – Agree
3 – Neutral
2 – Disagree
1 – Strongly Disagree

These responses are compiled in Table 2, titled Survey Questionnaire, and form the basis for the subsequent evaluation.

nsights into the overall performance of the system, highlighting both strengths and areas that may benefit from future enhancements

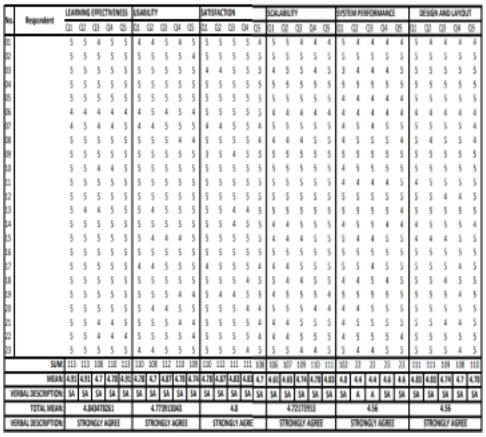

Table 1 Survey Questionnaire

Table 1: Learning Effectiveness (Mean = 4.84, Excellent)

Section 1: Learning Effectiveness		**Mean**	**Interpretation**
Item 1	ARSCI helps me understand science and technology concepts better.	4.9	Strongly Agree
Item 2	Using ARSCI improves my ability to remember what I learn.	4.9	Strongly Agree
Item 3	I feel more confident about the topics after using ARSCI.	4.7	Strongly Agree
Item 4	ARSCI provides clear explanations of complex ideas.	4.7	Strongly Agree
Item 5	ARSCI helps me apply what I've learned to real-world problems.	4.9	Strongly Agree
Total Mean		4.78	Strongly Agree

According to the results of the study, the results indicate that ARSCI is very effective in improving learning among learners in terms of understanding, memorizing and using Science and Technology concepts. There was a strongly agree between the respondents that the system supports interactive explanations, confidence, and the ability to apply knowledge to real-life situations. The mean of the section was 4.84 which proves that ARSCI is an efficient and most interactive teaching tool.

Table 2: Usability (Mean = 4.77, Excellent)

Section 2: Usability		**Mean**	**Interpretation**
Item 1	The ARSCI interface is easy to navigate.	4.7	Strongly Agree
Item 2	I can complete tasks quickly using ARSCI.	4.7	Strongly Agree
Item 3	Instructions within the system are clear and understandable.	4.8	Strongly Agree
Item 4	I rarely make errors when using ARSCI.	4.7	Strongly Agree
Item 5	I am confident to use ARSCI without outside assistance.	4.7	Strongly Agree
Total Mean		4.77	Strongly Agree

ARSCI was very useful and efficient to the respondents. The easy-to-use intuitive interface and clearly laid down menus enabled ease of navigation and minimized errors on the part of the user. The instructions were directed and easy to follow making the students carry out learning tasks with the least guidance. This average of 4.77 shows that ARSCI is a good tool that facilitates easy interaction with the user.

Table 3: Satisfaction (Mean = 4.8, Excellent)

Section 3: Satisfaction		**Mean**	**Interpretation**
Item 1	I am happy with my whole experience of using ARSCI.	4.7	Strongly Agree
Item 2	ARSCI is up to my expectation as a teaching tool.	4.8	Strongly Agree
Item 3	I would recommend ARSCI to others.	4.8	Strongly Agree
Item 4	I like to attend ARSCI as a learning process.	4.8	Strongly Agree
Item 5	I feel ARSCI makes learning Science and Technology more engaging.	4.7	Strongly Agree
Total Mean		4.8	Strongly Agree

ARSCI system attracted great satisfaction on its performance, usability and exciting design. They concurred that ARSCI was better than expected as a platform of learning, and science and technology were easier and more interactive. The overall mean of 4.84 proves that ARSCI is a good tool in making people satisfied and engaged, so it can be concluded that it is an effective educational tool.

Table 4: Scalability (Mean = 4.72 Excellent)

Section 4: Scalability		**Mean**	**Interpretation**
Item 1	1. ARSCI has the capability of high-usage without decelerating.	4.6	Strongly Agree
Item 2	2. New features can be added to ARSCI easily.	4.6	Strongly Agree
Item 3	3. ARSCI can handle high usage without slowing down.	4.7	Strongly Agree
Item 4	4. ARSCI is not affected when there are many users.	4.7	Strongly Agree
Item 5	5. ARSCI has the potential to expand to other subjects or topics.	4.8	Strongly Agree
Total Mean		4.72	Strongly Agree

The respondents supported the view that ARSCI can perform consistently even when it is heavily utilized. The system is scalable and allows updating features and potential connection with other subjects. The overall mean of 4.72 shows a high degree of system consistency and the future development and expansion.

Table 5: System Performance (Mean = 4.56, Excellent)

Section 5: system performance		**Mean**	**Interpretation**
Item 1	ARSCI has no crashes and errors.	4.8	Strongly Agree
Item 2	ARSCI has a satisfactorily quick response time.	4.4	Agree
Item 3	ARSCI can fast and securely retrieve AR content.	4.4	Agree
Item 4	I hardly have to encounter bugs when using ARSCI.	4.6	Strongly Agree
Item 5	Updates on systems enhance the performance of ARSCI.	4.6	Strongly Agree
Total Mean		4.56	Strongly Agree

The ARSCI system performed very reliably and consistently, and there were few crashes or technical problems. Respondents considered it stable, responsive, and capable of supporting augmented content efficiently. The overall average of 4.56 confirms that ARSCI is well-performing and reliable as a learning system in terms of technical aspects.

Table 6: Design and Layout (Mean = 4.56, Excellent)

Section 6: design and layout		**Mean**	**Interpretation**
Item 1	ARSCI is compatible to any screen size.	4.8	Strongly Agree
Item 2	The fonts, color, and buttons are consistent all through the application.	4.8	Strongly Agree
Item 3	The buttons perform their designated operations or actions.	4.7	Strongly Agree
Item 4	The arrangement of elements (text, images, AR content) supports effective learning.	4.7	Strongly Agree
Item 5	The overall design of ARSCI makes the learning experience more engaging.	4.7	Strongly Agree
Total Mean		4.56	Strongly Agree

The ARSCI design was clean, consistent, and engaging to the respondents. The harmonious application of color, typography and interactivity made the reading better and allowed better learning. The overall mean of 4.56 shows that the layout of the system is effective in terms of interactivity and accessibility to users regardless of the kind of device used.

Table 7: System Evaluation - Overall Results

Learning Effectiveness	**4.84**	**Strongly Agree**
Usability	4.77	Strongly Agree
Satisfaction	4.8	Strongly Agree
Scalability	4.72	Strongly Agree
System Performance	4.56	Strongly Agree
Design and Layout	4.56	Strongly Agree
Overall Weighted Mean	4.71	Strongly Agree

Overall Result

The evaluation of ARSCI: An Augmented Reality Learning Media in Grade VI students and teachers of the Lagao Central Elementary School showed that the evaluation had an overall mean of 4.71 (Strongly Agree), which means that the system is not only an efficient learning medium, but also a dependable learning platform. The results confirm that ARSCI attained its main goals of enhancing science learning, promoting student engagement and facilitating blended education. Having a good usability and high satisfaction level, ARSCI has a lot of potential concerning its wider implementation in other subjects, with only slight amendments to aspects of scalability and system optimization able to enhance its usefulness.

CONCLUSION

ARSCI: An Augmented Reality Learning Media in Science and Technology was developed and tested to help Grade VI students of Lagao central elementary school. The objectives of the study were to (1) design and develop the AR- based learning tool that helps to develop knowledge about the concepts of science, (2) evaluate the usability, satisfaction, scalability, the system performance and the design of the tool, and (3) identify the effectiveness of the tool as a whole in the facilitation of the interactive and engaging learning. The study outcomes can be concluded to show that ARSCI has been successful in meeting all its aims, and that it is a valuable and enriching learning experience to Grade VI students.

The following recommendations are based on the feedback to improve ARSCI:

1. Mobile Application Target User: Although the evaluators have not written their comment and recommendation on the evaluation sheets, most of the evaluator suggested that the mobile application would be more usable and effective for students under the program Personalized Learning Class (PLC) since the students, under the said program, most of the time studies independently making them not needing constant observation and a perfect target users of the application that promotes self-pace approach.
2. Mobile Application Functionality: Evaluator 1, Josephine T. Juanico, recommended that the mobile application should adapt to any screen size; tablets and smart phones. Evaluator 1 also mentioned that it would be nice if the application covers more lessons on science and other subjects that.

Therefore, the researchers conclude that the system showed great performance in all the areas evaluated proving the fact that ARSCI is a viable and pedagogically sound application in the practice of science learning.

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