# USING ANDROID PLATFORM FEATURES TO IMPROVE THE USE OF MOBILE DEVICES IN ASSISTED LEARNING FOR CHILDREN BELOW THE AGES OF TEN

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The traditional way of teaching is no longer sufficient for children in the 21st Century, with the rapid evolution of technology both technology we have on ground and emerging technologies that are upcoming, This study realize that there is need to embrace the change or risk being left behind with this study developed the "First teacher Educational application", an Android application meticulously designed to leverage mobile hardware and software to improve educational practices, particularly for children starting their educational journey. This application heavily emphasizes utilizing Near-Field Communication (NFC). NFC tags are employed to deliver educational content directly to the children. Moreover, the app incorporates the device's built-in capabilities: the camera and voice recorder are harnessed to enrich the learning environment. A key element, and one of paramount importance, is the application's focus on access control features. These features, using both software and hardware components, enable parents to supervise their child's device activities and keep them engaged within the learning application, thereby preventing them from navigating away during lessons.

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## Introduction

The acquisition of knowledge, comprehension, and skills is termed learning and is achieved through study, instruction, and practical application (Wale & Bishaw, 2020; Munna & Kalam, 2021). E-learning is defined as the "delivery of educational activities pertinent to instructing, teaching, and learning via various electronic mediums, like mobile devices and computers" (Haleem et al., 2022). An E-learning platform constitutes a dedicated system software that facilitates both the construction and delivery of educational activities through electronic means. The creation of electronic pedagogical tools for children is not a novel global phenomenon; it is widely implemented in regions such as the United States, Europe, parts of Asia, and Africa. In addition to the proliferation of information technology, many other processes have been digitised. Information technology has simplified and technologically enhanced daily activities, impacting everything from routines, facilitated by automated processes supported by information systems, educational methodologies in schools, and decision-making within major organisations (Spring et al., 2022; Rainer et al., 2020). Consequently, with the rapid advancement of information technology in Nigeria and worldwide, children are embracing these technologies. The younger generation widely utilises technological gadgets and tools, suggesting a future in which manual paper-based systems will be obsolete and their usage relegated to history (Shneiderman, 2020; Davenport & Miller, 2022). Today's children are digital natives born into the information age and are familiar with information systems from their earliest years (Davis, 2023; Wall, 2024). Aligning with the habits of these digital natives, automating the learning process at an early age is reasonable.

Nigeria, the largest economy in Africa, has experienced a dramatic surge in information technology since the new millennium, resulting in over half of the population owning mobile devices and being aware of current technological trends (Enahoro & Olawade, 2021; Bolat, 2019). Children are becoming more capable of interacting with new information systems and integrating them into everyday routines. Mobile devices have evolved into personal identifiers (PIs). For instance, mobile phone numbers can uniquely identify individuals. Thanks to the wide range of mobile services, children are using mobile devices earlier, frequently coming into contact with them by the age of four. This trend necessitates safeguards against unauthorised content such as sensitive messages and inappropriate Internet material within mobile phone applications.

Many mobile application developers have capitalised on advancements in mobile information system technologies by creating innovative applications that enhance children's academic abilities. However, many of these applications fail to provide adequate access controls to protect children from unsolicited data. This deficiency was the focus of this study. In addition, several applications lack essential haptic effects, which leads to disinterest and, more importantly, neglect of the mobile device's hardware and software features that could amplify the learning experience.

The Android platform, which utilises JAVA and other programming languages, is an open source system for application development (Tewari & Singh, 2021; Sarkar et al., 2019). Google provides it, making it freely accessible to all developers. Utilising the Android platform for app development is beneficial because of its free and efficient nature. It promises "increased quality, greater stability, reduced costs, reliability, and rapid bug fixes' (Krasner, 2021; Winter et al., 2022). Open-source systems comprise software with publicly accessible source codes that enable anyone to copy, modify, and redistribute them without financial charges or royalties and without legal implications based on their usage. In this study, we implemented an Android platform for the development of the proposed application. Its extensive user base stems from its cost-effectiveness, ease of use, mobile market availability, and open source nature for application development. The application was implemented using the JAVA programming language and developed within Android Studio IDE.

**Problem Statement**

The transition to electronic learning platforms within Nigeria's educational infrastructure is critical for fostering economic advancement, with the aim of becoming a top global economy by 2030. However, existing e-learning systems currently present specific deficiencies, which are outlined as follows

- User Access Restrictions: A major issue stems from unrestricted access to mobile phone functionalities. With children's increasing interactions with mobile devices, safeguarding them from accessing restricted areas is paramount. This includes preventing the unintended deletion of essential data on parents' phones, along with unauthorised browsing of unsuitable websites.
- Enhancing Engagement through Haptic Feedback: The lack of haptic features in most current educational applications contributes to decreased engagement and motivation. Incorporating tactile responses, such as vibrations, visual cues (light flashes), and auditory outputs, is essential to maintain children's attention and enthusiasm while using the app. Children's focus tended to wane quickly. Consequently, employing haptic effects is essential for constructing a more engaging and fun learning environment.

- Application Usage Control: The absence of time restrictions within many existing applications allows continuous operation. This extended usage presents challenges for both child welfare and the operational life cycle of the device. Implementing time limits is crucial to address possible detrimental impacts of screen exposure and other aspects linked to device usage.
- The inadequate leveraging of device hardware and software to optimise the learning experience often neglects the capabilities inherent in mobile devices.

**Aim**

The primary objective of this research is to design and implement a dynamic Android application that leverages both hardware and software features to generate a safe and engaging learning environment for children under the age of 10.

**Objectives**

This research endeavours to achieve the following objectives.

- Determine the typical age at which children in Nigeria begin using mobile devices.
- Explore parental perspectives regarding their children's mobile device usage, covering both positive and negative concerns.
- Identify the types of applications children typically use on their mobile devices.
- Investigating the efficacy of haptic effects in promoting children's involvement in mobile device applications.
- Investigate incorporating mobile device hardware and software capabilities to improve children's educational processes during their learning stages.
- Evaluate existing access control methods to safeguard children from accessing potentially inappropriate content on their devices (e.g. web browsers and messaging applications).

**Related Works**

Currently, reliance solely on manual teaching methods is becoming insufficient. The information age has spurred the advancement of intelligent information systems, where the Internet and elements such as big data are indispensable. Obsolete manual systems are not sustainable and developing nations cannot afford to persist with them. The ongoing progress in information technology demands that countries remain competitive; failing to do so will jeopardise their chances of being key players in current and future economies. Many e-learning systems that are pertinent to this research have been examined. Many publications concentrate on e-learning applications specifically tailored to business settings, while others explore open and accessible source systems, evaluation techniques for e-learning systems, and the theoretical frameworks of open-source systems relevant to the topic.

Ahmad et al. (2022) explored ontological approaches to classify various educational resources, thereby helping learners improve their learning outcomes within e-learning environments. This study describes the learning management process and the various ontologies employed, specifically those concerning the educational domain, electronic learning resources, learner profiles, and individual collections. Furthermore, it describes the reasoning rules and algorithms required to retrieve and combine distributed learning resources to establish personalised collections. This helps simplify the learning process, and the system can simultaneously manage both tutor and student activities.

Chatterjee et al. (2020) highlights the utilization of cloud computing in mobile e-educational systems to expand the availability of academic material. It also discusses hosting learning resources on the cloud, mitigating reliance on physical mobile storage, advocating for the adoption of e-learning across all educational sectors, and increasing student access to e-services.

Alghazi et al. (2020) investigated the impact of mobile and wireless technologies on the education sector. Their findings showed positive outcomes, particularly emphasising mobile learning tools (MOBT) as a valuable technique for improving e-learning. This study outlines the key theoretical frameworks that are fundamental to mobile e-learning applications. Block Magic, a European research endeavour supported by the LLP-Comenius initiative, seeks to merge physical manipulation with technology (Volta, 2020; Cefai et. al., 2022). The primary objective was to revive conventional psycho-pedagogical techniques that drew inspiration from the Montessori method, thereby fostering active learning to encourage full student involvement while harnessing modern technologies. The team built a functional prototype by leveraging the Logical Blocks Box, which is commonly found in various educational settings, such as kindergartens, primary schools, rehabilitation facilities, and private homes. The Block Magic research team created an active desk/board equipped to identify tangible blocks that featured RFID passive tags. An integrated RFID reader was embedded within the upgraded magic blocks. Each block was detected wirelessly by using a sensor. An active board, designed with a wireless RFID reader, facilitates the reading of RFID tags on a block and sends data to the Block Magic software engine. Figure 1 shows a sample application.

The distinguishing feature of this study, relative to the previous literature, is the development of an educational application which enables access control, going beyond the fundamental provision of educational content. Further, the increasing prevalence of mobile devices underscores the need for haptic feedback to improve user experience. This research intends to simplify this complex subject of e-learning by focusing on the hardware and software capabilities of mobile devices. Most studies have focused on either hardware or software, whereas this study endeavours to integrate both to improve the delivery of education.

**Methodology**

This section outlines the research specifications, details the development and analysis methodologies employed, and justifies their selection. It also clarifies the scope and limitations of the project. Furthermore, this section provides a concise examination of existing systems, outlines data-gathering methods used to collect information, and presents relevant diagrams pertinent to system development. We also elaborate on the overall design process for the "First Teacher" ’smobile application, describing its operational workflows and behavioural patterns. UML diagrams are utilised to promote understanding and facilitate the gathering of requirements. Finally, it identifies how the system utilises both internal and external subcomponents to function effectively.

Agile Methodology: This offers a flexible structure for initiating programming and design tasks. As a lightweight approach, it minimises risks by organising the software development process within short time boxes or iterations, typically lasting one–four weeks. Each iteration, which is smaller than the traditional software development processes, incorporates all the tasks necessary to release a scaled-down version with new features. These tasks included planning, requirements analysis, design, coding, testing, and documentation. Even if an iteration does not completely release a new version, the agile process aims for readiness at the end of each cycle to release new programs. At the conclusion of each cycle, the development team re-convenes to re-evaluate customer needs (Sadowski & Zimmermann, 2019; Liu et. al., 2023).

Object Reuse Methodology: This methodology focuses on repurposing pre-existing, similar object functionalities during application development. It is cost-effective and saves both time and resources. This results in a decreased need for extensive programming, and accelerates the project timeline.

**Methodology Choice**

The development phase of this project integrates both agile and object-reuse methodologies.

- Time Constraints: Given the project's relatively short timeframe (maximum of eight months), the combination of Agile and Object Reuse methodologies is the most practical choice.
- Budgetary Limitations: Limited financial resources for comprehensive documentation and design make Object Reuse appealing, allowing for significantly reduced costs.
- Lack of flexibility in plan-driven methodology: The inherent rigidity of plan-driven methodologies is unsuitable given the client's potential need for frequent requirements and functionality adjustments.
- Enhanced Understanding of Client Needs: Direct communication with the client will aid in gathering clearer requirements compared to plan-driven methodologies, which often involve minimal client interaction.
- Increased Client Involvement: The emphasis will be on client participation rather than solely relying on extensive documentation.

**Existing System Analysis**

Since the development of mobile applications, developers have created numerous useful applications. Examples include WhatsApp, Telegram, Signal, and BBM. These applications allow users to synchronise their daily tasks. Furthermore, educational applications such as Evernote Peek, Wolfram Alpha, and Studious have been developed.

**Key Differentiators**

The following distinctions set the application under development, apart from those mentioned earlier:

Access Restriction: The application's capability to restrict users from accessing unauthorised parts of the mobile device represents a significant advantage. Many educational apps are used on parents' phones, which frequently contain essential personal and valuable information. Children might inadvertently access and potentially alter or delete this data. Therefore, this key feature distinguishes the project from other alternatives.

Enhanced User Experience: The application will be developed to incorporate haptic and interactive effects. The aim is to improve usability and enhance user interaction, thereby promoting engagement. Most of the previously mentioned systems fulfil basic requirements, with limited consideration of other aspects of user experience. They do not fully utilise mobile hardware and software capabilities for enhancement.

**Requirements**

This will provide a detailed explanation of the "First Teacher" 's functional (Table 1) and non-functional requirements.

Functional Requirements

The functional requirements describe what the system must be capable of achieving its business objectives. Table 1 lists all the functional requirements of the application.

**Table 1 showing the functional requirements of the application**

| Pseudo code | Requirements |
|---|---|
| FR001 | The system should allow access to registered users. |
| FR002 | The System should be able to restrict the user from accessing other Applications while using the application. |
| FR003 | The System should have a time limit for how long the user can be on the system. |
| FR004 | The system should be able to store information on the memory card. |
| FR005 | The system should provide a means of authentication and verification on registration complete. |
| FR006 | The system should implement text to speech. |
| FR007 | The system should be able to access the phone camera. |
| FR008 | The system should enable registered user to exit the application after they sign out. |
| FR009 | The System should enable the user to deactivate the return button functionality. |
| FR010 | The System should be enabling the user to read to an NFC tag |
| FR011 | The system should be enabling the user to write to an NFC tag |
| FR012 | The System should enable the user to record voice clips. |
| FR013 | The system should enable the user to send feedback emails to the developer |
| FR014 | The system should enable the user to change password. |
| FR015 | The system should enable the user to delete his or her account. |
| FR016 | The system should enable the user to access the mobile camera. |
| FR017 | The system should provide quiz for the user. |
| FR018 | The system should enable the user to use the touch functionalities. |

This table presents the functional requirements of the system.

These functional requirements represent a collection of functionalities that the system must execute to achieve its objectives.

**Non-functional Requirement**

Non-functional requirements define the characteristics a system should possess to enhance the user experience; they are not strictly essential for core system operation. The non-functional aspects include Performance Capacity, Maintainability, Reliability, and Security.

**System Architecture**

The system architecture of an application provides a visual representation of the application, outlining its workflow and operational behaviours. This architecture also depicts the structure of the system and the connections between its internal and external components. Figure 2 presents the application architecture for the initial "first teacher" application.

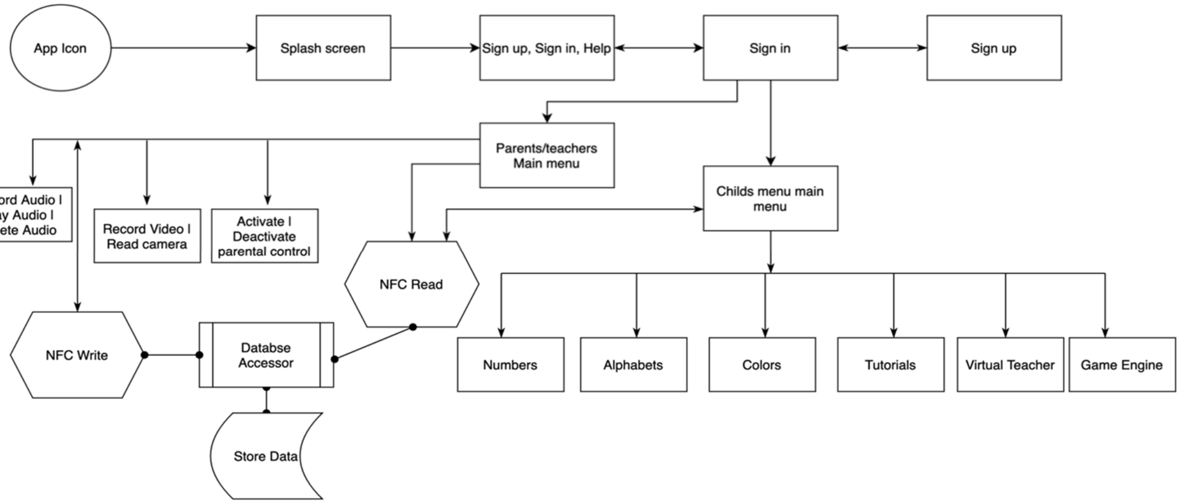



**Figure 2 shows the system architecture**

Figure 2 shows the system architecture designed for the application which shows the flow of activities within and outside the application and subprocess.

**System use case**

Use Case diagrams visually represent how users, also called actors, interact with a system. These diagrams offer a user-centric perspective that illustrates the capabilities of a system. They depict the features and actions initiated by the user, assuming the role of the actor. For instance, Figure 3 demonstrates some concrete examples of use cases within the application, along with a visualisation of the user's interactions with specific scenarios.

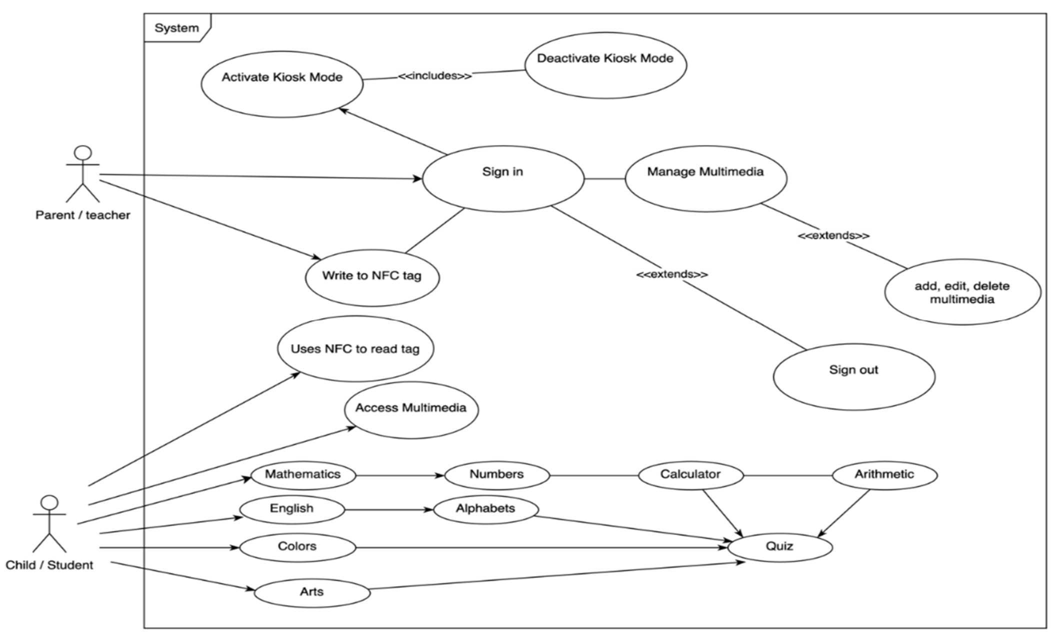



**Figure 3 shows the system usecase**

Depicted in Figure 3 is an overview of the system's interactive dynamics, specifically illustrating the engagement between a parent and their child.

The use case delineates a virtual embodiment of exchanges transpiring between the user and the system itself.

**Sequence diagram**

Sequence diagrams serve as visual tools that chart a series of tasks and processes that interact with the system, its subordinate processes, and various applications. Figure 4 presents a sequence diagram that specifically outlines the interactions involved when different users accessed the initial teacher application.

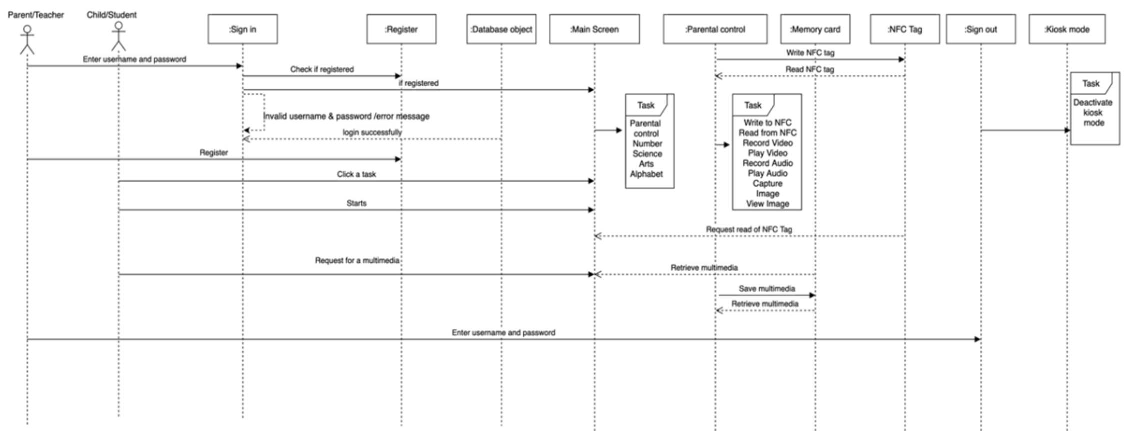



Figure 4 showing the series of tasks and actions of the parent's interaction with the system

**Story board diagram**

A storyboard, a sequence comprising sketches, typically represents the information flow within a system and serves to showcase the designed functionalities and operations of the system. Figure 5 illustrates the entire storyboard, detailing all interactions within the application.

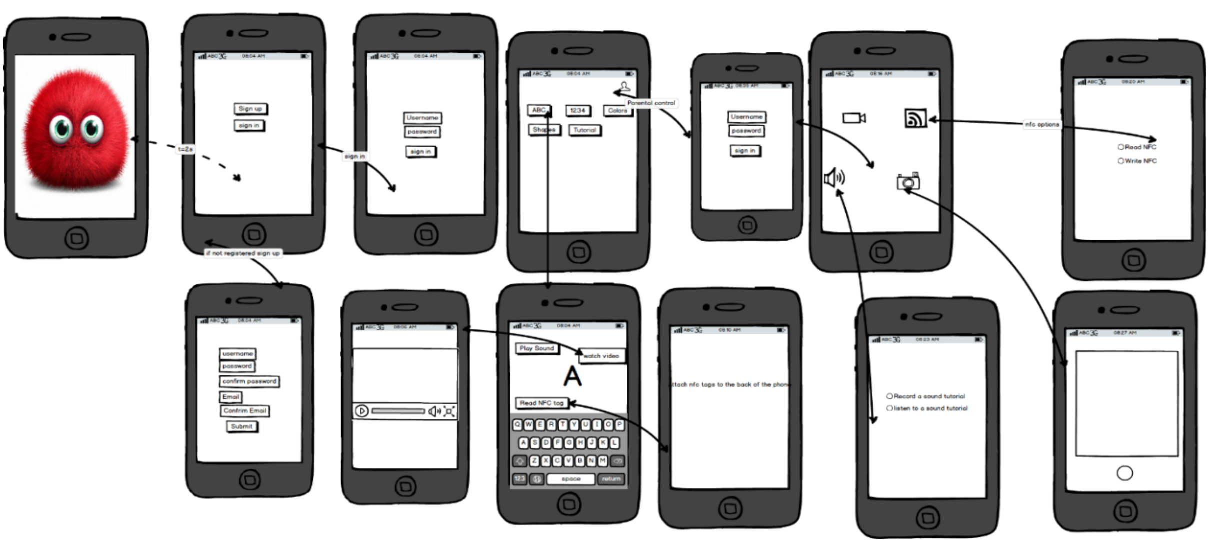


Figure 5 showing the series of process and actions involved in the application

**User interface screen shot**

The user interface design presents a virtual portrayal of the visual aspects and functionality of the application.

The user interface of the application is shown in Figures 6 and 7.

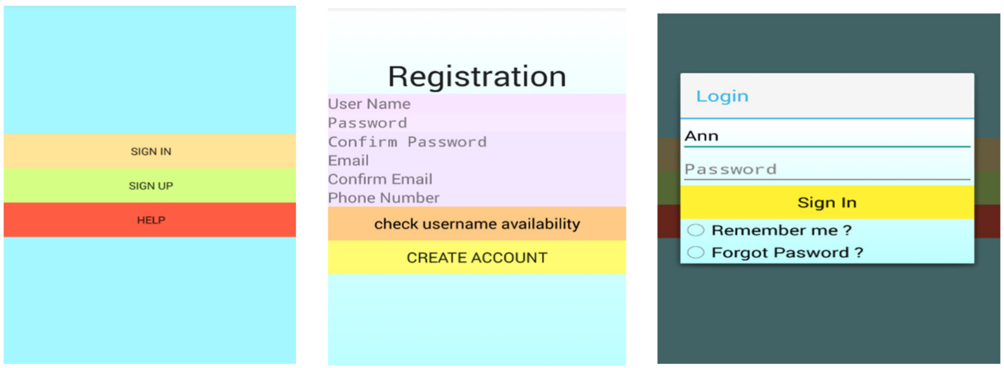



Figure 6 showing the sign up and sign in user interface

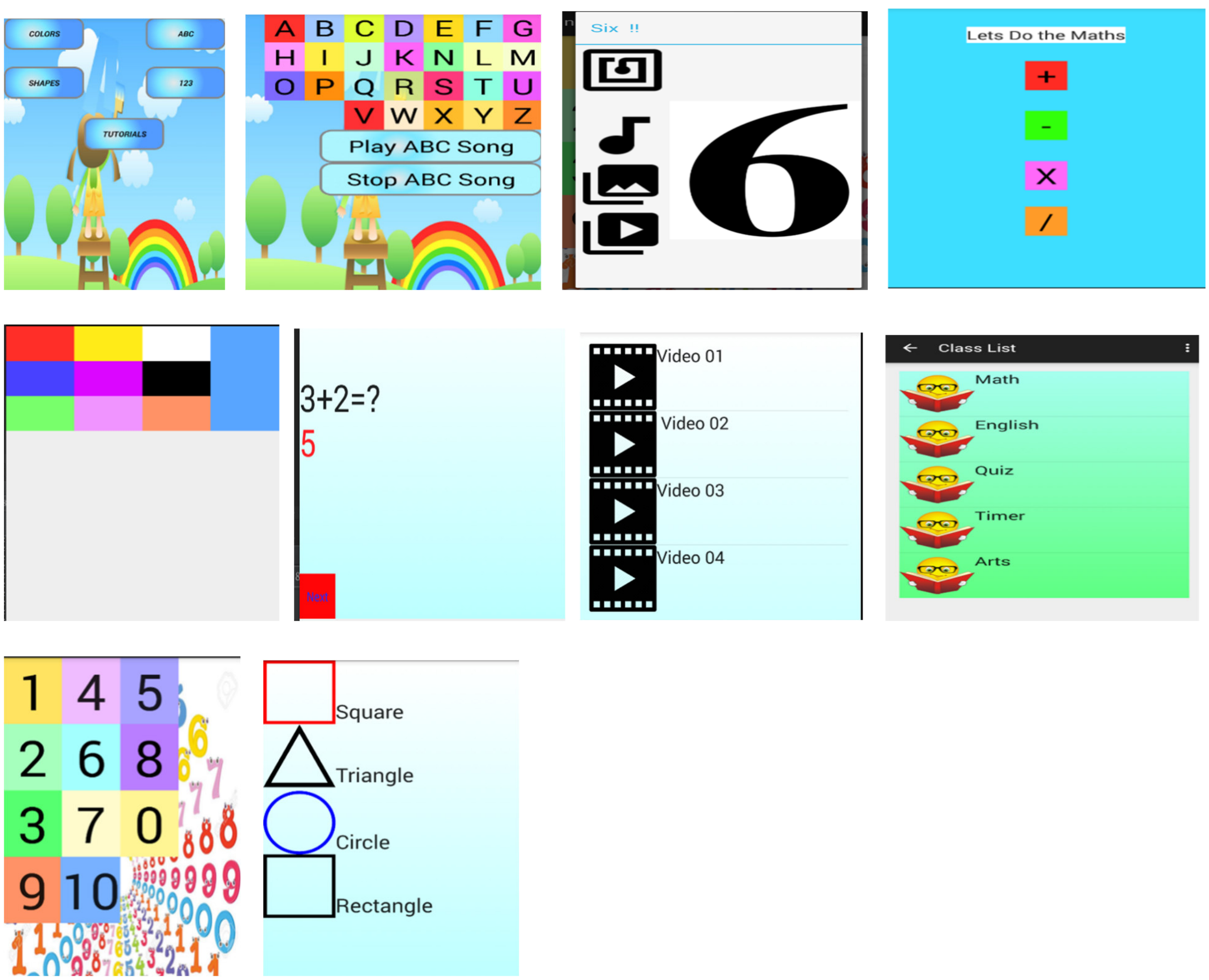



Figure 7 user interface of the application showing major functionality

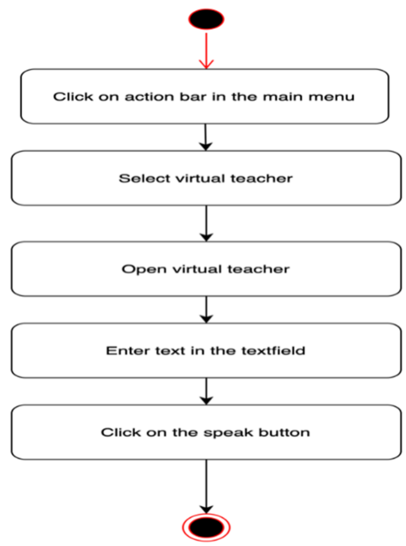
**Activity diagram**

An activity diagram provides a model outlining the sequential display of tasks or actions derived from a specific use case. This is shown in Figs. 8 and 9.

Figure 8, an activity diagram, highlights the user's interaction with the virtual teacher function

Figure 8, an activity diagram, shows the user's interaction with the virtual teacher function.

As shown in Figure 8, this activity diagram depicts the process by which a logged-in user accesses the virtual teacher function. Upon login, the user clicks the action bar at the top and selects the virtual teacher function. This launches the virtual teacher activity, allowing the user to input text and click the 'speak' button for the output.



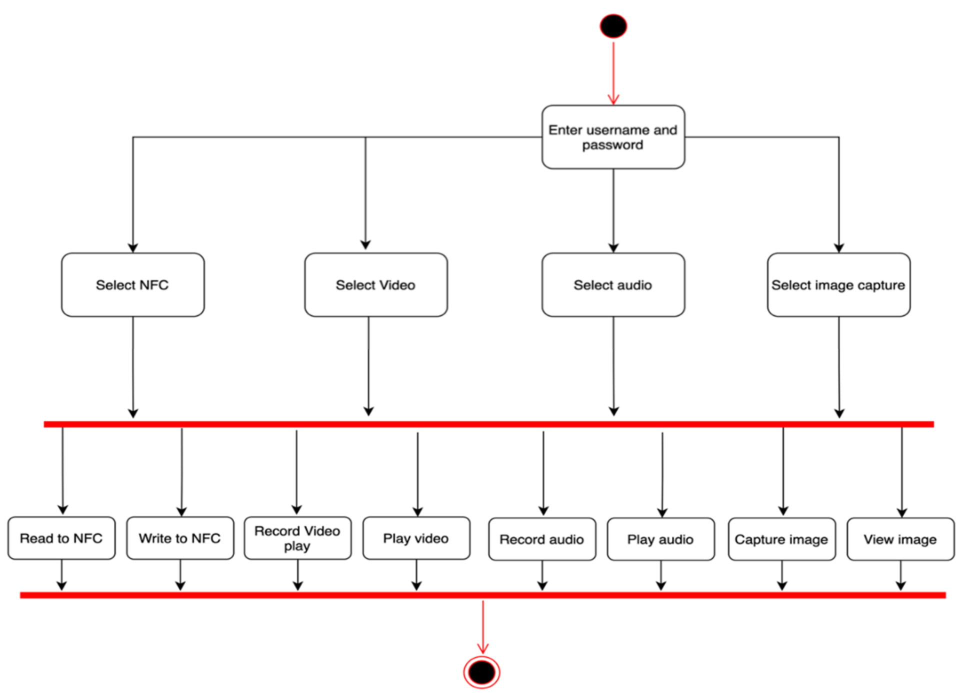




Figure 9 shows an activity diagram that maps the interactions with the combined hardware and software aimed at enhancing the educational procedure.

This activity diagram (Figure 9) portrays the actions that occur within the system when a parent is logged in by utilising parental functions. Upon logging in, the user clicks on the action bar and selects the parental icon. Subsequently, the password promptly appears, and upon entering the correct password, the parental activity opens, presenting various options to the parent. The parent can perform multiple tasks, such as reading or writing, on an NFC tag.

**Implementation And Testing**

The system was put into effect directly following its design phase, which was created using the CASE tools. Initially, this stage focused on building the code for the Kiosk mode, starting with the teacher's section. The JAVA programming language on the Android framework was utilised for system implementation. The IDE requires the Android Software Development Kit (SDK) to be installed as a plugin to function correctly within the Android framework. Preliminary research was crucial before beginning the application development, and subsequently, the creation of the splash screen, followed by the sign-in and sign-up pages. After the sign-up and sign-in pages were designed and put into action, database development was carried out, followed by the menu pages for the parent and child areas. Subsequently, the Kiosk mode was designed and executed, with numerous investigations preceding the implementation to match the design standards. Next came the NFC capability, which also involved much research into the NFC functionality, making it possible for the device to read from and write to NFC tags. After the preceding stage was completed, the text-to-speech feature was studied and incorporated, contributing to the design of virtual teacher functionality. Finally, the design and implementation of a quiz area led to development. The testing phase included the debugging procedure during development, which was used to discover what aspects were functioning as intended and which ones did not, along with addressing debugging solutions. Testing involved debugging the program, fixing errors, and identifying faults in the system. Unit testing targets particular classes or methods to evaluate specific features. Integration testing assessed whether all classes operating together functioned harmoniously as a collective unit. The complete system was assessed during system testing to examine its functional and nonfunctional requirements. Testing was completed by designing several test scenarios to check each feature of the application.

**Conclusion and Recommendations**

This paper has examined the creation, execution, and evaluation of an initial teacher-focused Android application, highlighting the essential features and requisites crucial for the success of the application. A substantial portion of the investigation focused on the development of educational applications encompassing both mobile and desktop platforms. Furthermore, near-field communication technologies and their potential integration into e-learning applications to improve learning methodologies have been extensively studied. The utilisation of mobile device hardware and software was investigated to improve children 's learning journeys. Owing to time constraints in development and research, not all the intended functionalities were incorporated. One notable omission was a time management system, which would have helped regulate the child's usage duration to prevent excessive use which can cause physical complications such as eyestrain. This feature can be added later, along with further functional improvements. The application achieved its original objectives, and with further enhancements, it has potential for even more improved performance.

**Recommendations**

It is recommended that continuous research into new avenues for improving and refining digital educational experience, specifically leveraging evolving technologies such as machine learning and virtual reality, be carried out consistently. This approach is important because technology advances rapidly, presenting innovative opportunities for refining existing processes and enriching them to promote a better future for education.

**Future Enhancements**

In the future, improvements can be made to the user interface through visually appealing, interactive, and meaningful multimedia content. Additional functionality, such as voice recognition and artificial intelligence, will be examined and integrated in future iterations. Moreover, expanding the compatibility of the application with other operating systems, such as Windows and iOS, presents further development opportunities. Currently, the application operates only on Android operating system.

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