Augmented Reality Enhanced Computer Aided Learning for Young Children

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Abstract— **Learning to write can be exhausting for young children. In Traditional teaching, children with a different learning abilities are taught with the same rubric. This, in turn, impacts children that need extra attention to catch up with their pairs, which leads children to suffer right from the early learning stages. Traditional teaching methods also are so rigid that makes them unable to automatically identify those children with less abilities and in need of extra work. Hence, with the rapid development of ICT, an innovative learning methods are sought to be important to allow children to be taught with different rubrics. The aim of this research is to improve learning process for pre-school children via introducing Augmented Reality (AR) in the process which, in turn, simplify the learning process as well as identifying children abilities. The research introduces gamification to the process in order to ease the burden on children. Furthermore, we are trying to involve both school as well home to be part of the educational cycle that makes parents to be part of the learning/educational process of their *young children*. Augmented reality combined with pleasing sound make the learning more interactive and enjoyable. The outcome of this research also helps parents to keep track of their children's learning. The paper also describes the deployment of the application in a local schools as a pilot study so teachers can get feedback on student's learning curve and to fine tune the work further.**

Keywords— Augmented Reality, Education, Cloud Computing, Mobile Application

I. INTRODUCTION

The rapid evolvement of technology in recent years has provided numerous advancements in both the economy and the society. Technology has provided many possibilities to the world of education as a whole for example looking at a complete heart beating in the middle of a classroom. It has already ceased to be science fiction and is entirely possible having the appropriate devices [1]. Augmented Reality (AR) a term invented by a former Boeing researcher named Thomas P. Caudell. This was a separate new direction of virtual reality not simply a new name for an existing concept, which propagated to become a distinctive branch or field on its own [1]. Unlike virtual reality, augmented reality unlocks and creates layers of digital information on top of the physical world that can be viewed through mobile devices. Teachers understand that, learning expands, not just through reading and listening, but also through creating and interacting. Hence, with augmented reality[3], student can work in an interactive and fun way [2] to enhance children education by adding augmented objects into their real-life learning process.

A. The Research Problem

Majority of parents are trying as much as possible to participate in their children's learning process. However, this participation does not occur, in most cases, at the early stages of child development and education. This is crucial because not only does literacy development starts early in life and is highly correlated with school achievement, but would limit the child experiences with language and literacy the more likely he or she will have difficulty in learning to read. Writing can be a complex exercise for young children, especially those that suffer from some sort of condition such as dysgraphia. Furthermore, the rapid development of ICT in recent years has enabled researchers to develop new methods that contribute to the education of children in a constructive manner.

School and home are separate entities that have different teaching methodologies in most cases. These differentiations have a negative impact on child learning. In order to minimize and eventually eliminating these differences, it is essential to align both methodologies to ensure that the learning process is consistent across both entities. Thus, a framework is required to increase the coupling and collaboration among the different entities associated with children learning. The framework needed not only to couple the school and home but also to decrease the burden and stress on child learning process.

B. Motivation

In order to reduce the learning stress on children while providing them with the traditional teaching methodologies, this research

paper proposes a framework that integrates available technologies with traditional school paper-based learning to help literacy development. This will give the child the opportunity to learn at different bases depending on the child learning ability. The framework proposed here is to create collaboration between school and parents where both parties can monitor development of the child 24/7. Hence, learning weaknesses can be identified as well as identifying conditions such as dysgraphia at early stages because parents will be engaged in the monitoring of children development process.

Memorizing games are added to the process in order to make the learning more interactive and enjoyable. The purpose of this research is to help parents but mainly the child in developing an early relationship with one another by learning. Parents acknowledge the skill level of their children at an early stage and children with dysgraphia or even dyslexia can be diagnosed and measures can be put in place.

This paper is structured as related work, followed by the motivation that is led this research. Section III, describes the framework of the proposed system. Results discussions are presented in section IV. Conclusions are demonstrated in section V.

II. RELATED WORK

It is well known that providing young children with exceptional writing experiences can lay good foundations for literacy learning at such a young age. As a result, this often increases the mental development of these young children. Although there is lack of in depth research on writing, findings reveal that writing among young children that include but not limited to name writing is associated with later reading and other literacy skills [4]. In fact, in some cases, studies show that development in writing somehow predicts other literal skills such as reading, spelling and decoding reading comprehension in first grade [5], and spelling in second grade [6].

At a young children level of writing, they often practice the pattern of alphabets one way or another, which leads to understanding the relationship between sounds and the letters they represent. Ultimately the child's uses this to build on the understanding of the alphabetic principle that is a particular letter accounts for an individual word [7]. Some studies show that there is an actual evidence indicating that early writing is of great significant to the literacy development of young children. Therefore, it is very imperative that writing should be integrated into young children's learning environment.

Every process in life requires many stages that lead to be developed fully. Young children's writing is not of an exception and ample research indicates that young children progress through various stages of writing as they develop writing skills [7][8].

In 2009 Schickedanz and Casbergue provided a comprehensive picture of preschoolers' writing development as they develop from drawing lines to meaningful letters. Young children often begin writing using small lines on pages that may not be of any resemblance to letters in the alphabet or drawing pictures that communicate or doesn't communicate a message. An article by Traci [9], shows that at this stage parents often encourage their young children by doing at least one of the followings:

Air writing: where the child writes letters in the air first so as to strengthen the muscles and help the child progress faster,

Foamy fun: this occurred while taking a bath the parent spatters a touch of shaving cream on the sidewall. Because of the cloud-like feeling of the cream, the child will associate writing with fun, and this will further his or her writing skills,

Learn your letters: The parent give the child a size A4 paper and show them different patterns of various letters

Next, young children begin to make continuous scribbles while forming a consistent shape, often a looping pattern or zigzag. Then, writing starts to represent separate letter-like symbols or forms. Another article [10] shows that to develop writing skills better at early stages parents and teachers should make young children write their names first (name writing). Use their fingers when writing on sand trays again to strengthen the hand muscles, offer exciting tools for learning and unique writing experiences, and finally to trace drawings and keep a journal of previous work done [11].

After that stage, writing begins to look similar to actual letters of the alphabet and then children begin to associate shapes with letters. Consequently, children then start a technique called invented spelling which basically is when the child begins to spell words based on sounds heard in spoken language often beginning with isolated, conspicuous sounds and gradually moving toward accurate spelling [12][13].

The ultimate objective of learning is to write a word accurately, however, it seems that there is inconsistency among young children. This is due to the fact that they keep going back and forth between these stages, usually as they move from lower level of writing to higher level. Or other forms of writing (name writing, word writing, story writing). Sulzby and Teale [14] stated that all forms of writing are considered emergent and developing writing.

III. PROPOSED SYSTEM

Integrating technology with school traditional learning can be established by creating a user ID to every child that enable both school and parents to use in order to monitor the development of the child 24/7. This can be done via generating a paper with the relevant alphabets at the first instance. This paper has QR code and an AR marker that are embedded within, as shown in figure 1. AR is used to identify the alphabets available on the sheet, while the QR has all child details such as id, name, sheet number, language used, etc. The framework was developed as a mobile application that provides the child a series of activities to perform such as writing manually on paper as shown in figure 1. This will then be uploaded to the server to be assessed based on the way the child performed the writing activity, with the help of character recognition algorithms that are used by the applications using OpenCv. The results will then be populated and made available on the child's account on the cloud. Both parents and teachers can view these results in order to check the learning progress. Furthermore, the school can check the progress of each child as well as the possibility of reviewing a group of children within the same class. The latter is based on

each letter where the class average is calculated and then any weaknesses can be identified as shown in figures 6 and 7. In addition, the object recognition game embedded in the application is added as an incentive to encourage the child and also to enhance his memorization skills as shown in figure 2.
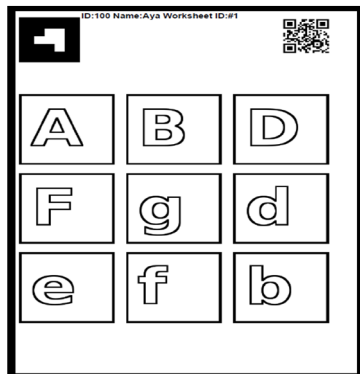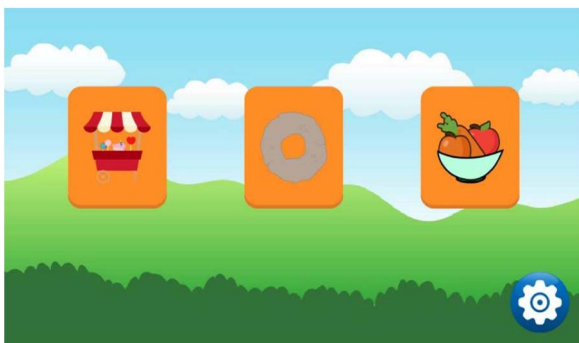

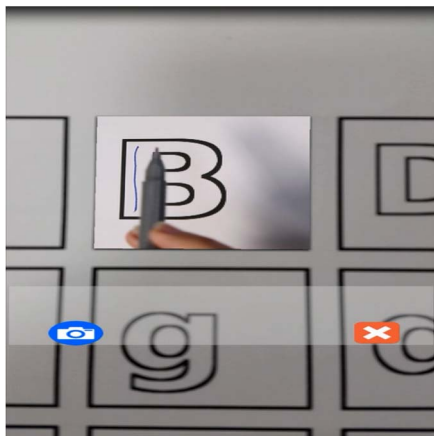Figure 1. Task worksheet prototype

Figure 2: Game home screen

Figure 3. AR video of a child perform the writing activity

A. Design Specification

In recent times, the use of mobile applications for learning purposes and mostly for playing games by almost everybody especially young children and for most of adult use mobile phones applications for further use such as social media has become the major trend. On that account, the proposed system is developed to have an environment that comprises of augmented reality accompanied with pleasing sounds to hamper the learning process. The framework consists of mainly three components; Mobile application, a printer used for printing the different learning tasks, and server application used for analyzing the completed tasks, and a cloud services that links the client application with that in the cloud.

The mobile application will mainly be focused on helping young children to write by giving them writing activity to perform on paper which will then be uploaded through the camera on the mobile device and later be analyzed using the image processing algorithm embedded to the application and the server furthermore, the result is displayed on the child's account linked with the cloud for the parent or tutor to review and compliment on. Finally, to encourage the child to perform this activity, an inbuilt object recognition game has been added, whereby when the child plays it, he automatically gets new activities to perform upon completion of each stage. In general, the framework is designed as a mobile application embedded with an object recognition game which was developed using unity and the cloud was developed using material design lite (mdl), for the server side, we used Golang which was cloud server computing, also we used OpenCv for the image processing and finally AR toolkit and vuforia were used to select useful AR design and templates to be used for the children interaction with the application.

Finally, as stated above the main goal of this application is to assess the writing capability and performance of young children and to help them improve at their own speed without pressuring them to perform extra boring task they are not willing to do.

B. Test Scenario

The test case involves prompting young children to use the object recognition game and use the work sheet to learn write alphabet. The framework assumes the child will write within the borders of the alphabets for it to be checked by the system. The overall scenario on how the framework works is as follow;

The parent of the child access the cloud to create an account for his child register his child to the framework by providing a username, password, language and local nursery, upon completion of child registration, the parent can download and print a worksheet of an activity automatically generated by the system. The child can on the mobile application start playing the object recognition game to enhance his/her memorization ability before even registering on the cloud by the parent, on account of playing the game, after completing a stage and before going to the next, the child is prompted by the system to take snapshot of the activity giving to him, for him to accurately perform the task, an AR embedded to the application shown in figure 3. will show a pop up video showing the child how to complete each giving task which is identified by the AR marker on each activity. Upon learning how to write the alphabet, the child is now required to complete the worksheet and take a snapshot of the worksheet, and the application will automatically recognize the user id and upload the sheet in to the user's workspace on the cloud.

OpenCv code and image processing algorithms on the server in the cloud will automatically analyze every new uploaded completed sheet and make available the Results of the progress on demand to both parent/teachers

In Addition, when both parents and teachers access/login again, the system analyze the progress of the child and present new sheet with new alphabets as well as those the child is having problem with which he needs more practice on them. Figure 4 below shows how the whole system works.
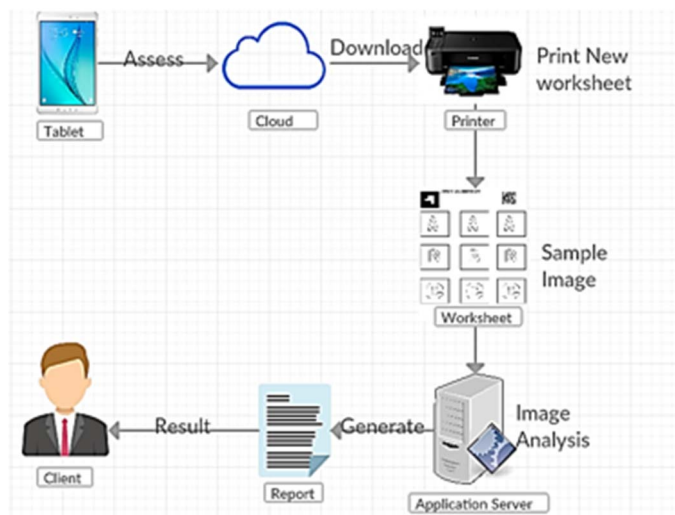

Figure 4. System Interaction Scenario

IV. RESULT AND DISCUSSIONS

A pilot survey was taking in one of the local nursery to test how children feel about it and how it will impact on their learning process. So far, the mobile application is developed specifically targeted for educational purpose. In order to analyze the results gathered from the test, the system automatically generate a progress report for the children that took the part in the survey which was uploaded to the cloud, as discussed earlier the parent and the school can review the progress of the child and this can be done by viewing the individual progress provided for each child in each given activity shown in figure 5. Nevertheless, the school can also check the progress of the whole class for a particular letter worked on by the children for the benefit of understanding those letters most children are having difficulties on and provide a working solution to both parents and teachers. These can be seen in figures figure 6. and figure 7. which shows the progress of the children based on each letter they worked on. In addition, the result populated from the pilot survey is shown in figures fig. 8 and figure. 9 it shows two different attempt by same children attempting to the same worksheet twice, as you can see in the two figures there is a slight increase in the performance of the children from the first attempt to the second attempts. Therefore, we can determine that children's experience, using our system enhance their ability of learning to write at an early stage with a shown statistics showing a positive improvement after a child's first attempt of a worksheet.
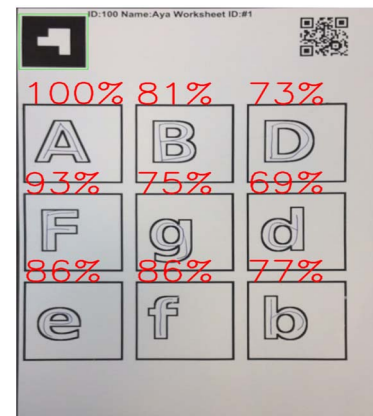

Figure 5. Calculated worksheet

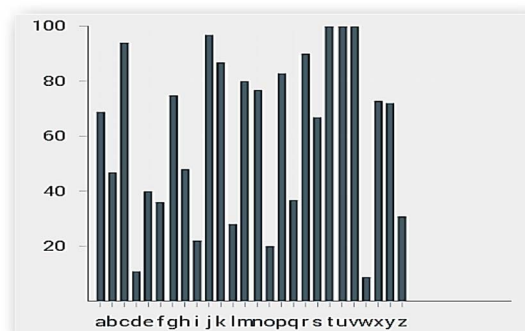Figure 6. Class Learning Progress per alphabet

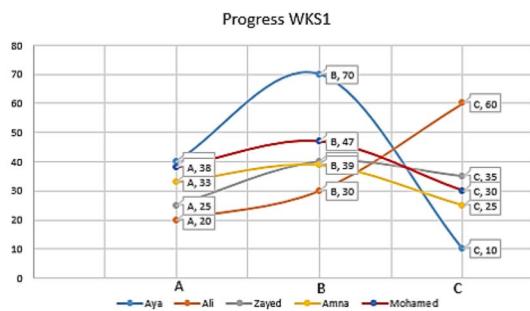Figure 7. Class Learning Progress per alphabet

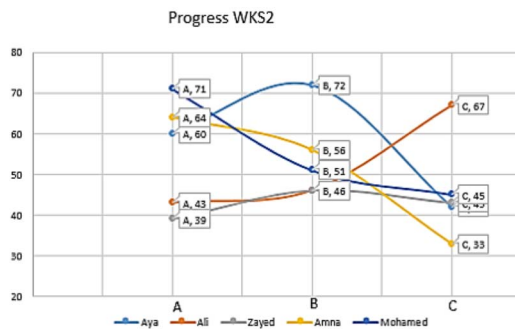Figure 8. Worksheet attempted by the children

Figure 9. Second Worksheet attempted by the children

V. CONCLUSION

To sum up, learning to write can be an exhausting and challenging task for young children at young age, whereby in traditional teaching the child learning abilities are not taken into consideration during teaching process and they are forced to learn to write more than their ability which make them not to pick up quickly. The aim of this project is to propose a system that will help young children by using the application, the child can learn at his/her own speed and also it encourages the involvement of parents to be part of the learning process by helping him print the task giving to him by the application and also by reviewing to know where the child have difficulty in writing. As a result of this, it will ease the pressure on teaching institutes when implementing the proposed application and also increase the participation of parents in the growth of their young children.

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