Computerization of Flash Cards in Early Childhood Education

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Abstract*: The education sector of Sri Lanka faced some major conversions with online education due to the Covid-19 pandemic and the country's economic crisis. Early childhood education was undebated in the development stages of the online education concept. This presented study aims at computerizing flashcards for early childhood education by developing an application that helps to fulfill the fundamental foundation of education for Sri Lankan children under the age of eight, with all three native languages Sinhala, Tamil, and English. This system is modelled focusing on detecting an object in an image concerning; the specific categories (numbers, letters, animals, fruits, vegetables) specialized for children under the age of 8 and giving the text as well as the audio output in all three native languages used inside the country. The categories were selected according to the NIE syllabus and their teaching methodologies. The detection process is done through a set of custom-trained models using TensorFlow and Keras. The models are built upon CNN and YOLO algorithms. The ability to get all three native languages are powered through the internal translators that will map the words with the languages. A mobile- based development through Kivy is chosen to ease the detection process, where the user can be given the ability of real-time detection. Each model was trained with 80+ classes that include 100+ images with an accuracy range from 70%-90%, which provides the user with vast diversity and high validity. The focus on developing this system is to introduce an online platform for the learning process of early childhood, which is lacking in the current Sri Lankan education system, and teaching young children all three languages used in means of communication inside the country while prioritizing early childhood education in online learning methodologies.*

Keywords: *Flash Cards, Computerization, Early Childhood Education*

1. Introduction

Developing a lifelong attachment with learning starts from the very early ages of a person. The foundation is necessary for a better future, whereas early childhood education is a crucial ingredient for education. With the globalization and development of technologies, most children are exposed to the technical world. Over the years, many opinions and ideas on computerizing early childhood education were brought into discussions as it has both positive and negative impacts on different aspects. Early childhood education is all about developing the vocabulary with building up understandings of meanings. This is the key for their development of knowledge which is identified as critical on expanding. Therefore, different types of materials and resources are used, which include Flash Cards. Flashcards can be known as the most common tool used in early childhood education. These cards use the Play and Inquiry method, one of the core methods used in education development, making the process more attractive. The concept of Computerizing Flash Cards was brought up from time to time with ideas such as Virtual Flash Cards and Augmented Reality (AR) Flash Cards. These concepts were developed related to the issues on traditional Flash Cards considering psychological, physical, and sensory functions of the children. The computerizing of Flash Cards was focused on contribution and logical grouping to enhance educating children. Traditional Flash Cards included still images that can make the children's perception of the vocabulary limited to a particular perspective. Having only visual clues where pronunciation was absent was another major drawback in Traditional Flash Cards. Screen Timing is the main issue that occurred in the implementation process as too much screen timing can cause attention difficulties, poor concentration, visual difficulties, muscular skeleton injuries, anti-social behaviors, and social isolation, which are significant effects on the physical and psychological wellbeing of children. To become active members of this digital world, children must be equipped and given the experience with proper guidance rather than avoiding computerizing the process of educating children as early experience with digital technologies help them to develop the necessary skills and fluency which is needed for the future. Although integrating technology into child-centered settings is challenging, it is always better to try rather than discuss whether technical tools can affect the education system positively or negatively.

The following research carried out help on the learning and teaching process of children under the age of eight through computerized flashcards. With the given methods it allows to analyze accurate object detection along with the voice outputs. The object recognition algorithms are

designed based on the deep learning models to detect objects using a camera. In addition, voice outputs are given using text-to-speech technologies. This paper introduces a much effective and efficient methodology that can fill a gap in online education sector of Sri Lanka.

2. Literature Review

A. Early Childhood Education

Early childhood is the period from birth to 8 years. This period can be categorized into three major stages according to the age groups as 0-3 years, 3-5 years, and 5-8 years(‘Technology in Early Childhood Education: Finding the Balance’). Early childhood education is focused on the age group 3-5 years as at that level, children begin to learn by recognizing objects around them through images, symbols, and sounds. This concept is much more complex than presented; at this phase, children tend to expand their vocabulary and understanding (Mertala, 2019; ‘EffectivePracticesinEarlyChildhoodEducation.pdf’).

In the 1960s, early childhood education was symbolized as one of the significant components in the educating process of children. Most of the children who had the opportunity at that time were from wealthy families. They introduced the concept of homeschooling to educate the children. Early childhood education was mainly focused on the children's cognitive, social, emotional, and physical development(‘EffectivePracticesinEarlyChildhoodEducation.pdf’).To achieve them, different conceptual perspectives of teaching were introduced under four main domains: literacy, numeracy, creativity, and critical thinking(‘Zomer and Kay - Technology Use in Early Childhood Education A Rev.pdf’; ‘Zomer - Technology Use in Early Childhood Education A Rev.pdf’).

By the time of 1980's the early childhood education became more outsourced to the society where preschool concepts started to emerge. Still, they were limited to a specific group of children due to poverty and state. By the late 19's, the preschool concept became a trend, and most children got the chance to attend preschools without any difference(‘EffectivePracticesinEarlyChildhoodEducation.pdf’).

The teaching processes were different from country to country due to the economic, social, cultural, and various political environments. Early childhood education expanded its boundaries with the massive parental involvement with globalization(Hägglund and Samuelsson, 2009). By the beginning of the '20s, researchers proved that the IQ level of children with well-designed early childhood education is higher than the others (‘Zomer - Technology Use in Early Childhood Education A Rev.pdf’).

The current world is a global village where technology has become a part of our lives. Children get exposed to these technologies from an early age. Teaching children the usage of technology from an early age can help them cope with this techno world as they grow. The best way to implement technology to children at an early age is to computerize their educational methodologies.

B. Need of computerized systems for early childhood education

The Digital revolution has profoundly affected how we live our lives with mobile devices and seamless integration of technology in everyday tasks such as shopping, working, reading, finding directions, etc.(‘Schindler et al. - 2017 - Computer-based technology and student engagement .pdf’).Technology is the most fast-growing field, which has made massive changes by digitalizing the daily life of most people(‘Lindeman et al. - 2021 - Digitalisation in early childhood education a dom.pdf’). The use of computers, mobile devices, and the internet is at its highest level up to date and continues to increase day by day. Technology in computing is a demanding field in many industries with unique opportunities. People struggle to keep up with the everyday changes(‘Schindler et al. - 2017 - Computer-based technology and student engagement .pdf’), where changes in this path should be experienced, and adaptations should be practiced for existence. This fact proves that learning and equipping them with technology from early childhood will thrive their future self with skills and knowledge on experiences(‘Fox-Turnbull - Enhancing the learning of technology in early chil.pdf’) needed for this fast-growing world.

It is said that "children do not universally wake up on their seventh birthday," in the same way children don't use technology directly. They will have to take experience and get used to the skills needed(‘Computers and Young Children A Review of Research.pdf’). Computers are already in homes and classrooms, and young children are already using them. And since technology is being used daily, educators can easily take advantage of the power of these tools to enhance the children’s learning process(‘Technology in Early Childhood Education Finding t.pdf’).

The World Economic Forum (2019) has stated the pressing issue of the 21st-century skill gap related to the digital revolution and how educators and researchers can address this using technology. Critical components of the 21st-century skill framework include collaboration, communication, critical thinking, and problem-solving, promising outputs on developing essential skills in young children(‘Kewalramani et al. - 2020 - Technology-integrated pedagogical practices a loo.pdf’). Branstord, Brown, and Cocking stated that "children lack knowledge and experience, but not reasoning ability" in the National Research Council study reports. They also stated that new technologies are consistent with the principles of learning

to solve this issue, such as new interactive technologies making it easier to create environments in which students can learn and technologies helping children visualize the concepts that are difficult to understand. These researchers have also proven that using technology in early learning guides; selecting the tools and creating the environment for changing technologies(‘Technology in Early Childhood Education Finding t.pdf’).

Computerized systems allocated from the very early stages can increase the children's experience while reacting and logically learning the technology. According to Hover and Austin, preschoolers with much interest in technology tend to have higher levels of cognitive maturity as they grow(‘Computers and Young Children A Review of Research.pdf’). All these facts prove that there is a need to computerize the educational system of early childhood to have a successful life in this globalized village.

C. Approaches on Computerization of early childhood education and its effects on computerizing a traditional methodology

Computerization of early childhood education is complex because there are many classifications and criteria to be considered as this is the basement of education given to the children. Children under the age of eight are playful and active souls that grab knowledge from every minor incident they face. Due to this fact, many researchers and practitioners have given much concern to understanding technology within children's play-based experiences. Implementing technology for this system needs effective planning, instruction, and reviews from test runs(‘Kewalramani et al. - 2020 - Technology-integrated pedagogical practices a loo.pdf’).

An adequate system will consider different views and aspects. Mainly when promoting technology in education, there are two aspects, namely, physical and virtual. Most of the current methods have proven that using a parallel run is the most effective method. This combination can be implemented using theoretical underpinning and frameworks, children's voice STEM-based play and experience, Pedagogy practices, and new realities(‘Kewalramani et al. - 2020 - Technology-integrated pedagogical practices a loo.pdf’). According to the age group that uses the technology, these methodologies will slightly differ as early childhood education has different weights. There are two main age categories: children between the ages of 3-5 years and children between 5-8 years(‘Technology in Early Childhood Education Finding t.pdf’). Implementations will be mainly focused on the ways of thinking, ways of working, tools for working, and skills needed for living in this digital world for children. These categories focus on developing the factors, which are social-emotional development and technology; physical development and technology; cognitive development and technology; language development and technology; mathematics development and technology and literacy development and technology.

To do the developments mentioned above, different types of technical tools are needed. Tools developed under this categories are divided into four main parts: informative, situating, constructive, and communicative tools. All these

facts should be embedded into one source, which can have a positive impact on interactions. Among all the equipment used in early childhood education, such as books, toys, and objects, flashcards are well known as commonly used. The computerization of flashcards is a joint research topic among most researchers on early childhood education(‘Chen and Chan - 2019 - Using Augmented Reality Flashcards to Learn Vocabu.pdf’).

D. Flashcards

We commonly see traditional flashcards as simply as a card consisting of a word, a sentence, or a sample picture (Azabdaftari and Mozaheb, 2012). They bear basic information with images that connects to the meaning of the word presented(‘Chen and Chan - 2019 - Using Augmented Reality Flashcards to Learn Vocabu.pdf’). Flashcards are commonly used for vocabulary development with a logical method of arrangement targeting words(‘Werling - The Effects of Technology in Early Childhood.pdf’). They are very famous in the learning and teaching process of early childhood education because of their simple, attractive, and colorful form. Flashcards improve not only language skills but also remembering and memorizing, enriching vocabulary, and analyzing problems. Still, traditional flashcards have only visual clues to the word's meaning; the pronunciation remains absent. They are still cards where only one image is presented per word, limiting the visual perception (‘Chen and Chan - 2019 - Using Augmented Reality Flashcards to Learn Vocabu.pdf’). Therefore, a flashcard is the best selection for computerizing early childhood education with the below-discussing implementations and overcoming the above-discussed limitations.

3. Methodology

The proposed system is a portable and easy to use digitalized learning platform for children under the age of eight; which is a mobile application. This is a computerized flashcard system that will read the detected item in all three native languages used in Sri Lanka: English, Sinhala, and Tamil while displaying the word with regard to the relevant language.

The application will allow the user to make a selection on the category of the item to be detected where the categories are specified according to the early childhood education syllabus of Sri Lanka which include numbers, animals, letters, fruits, vegetables, and day to day objects. The below-given diagram shows the overall end product application.

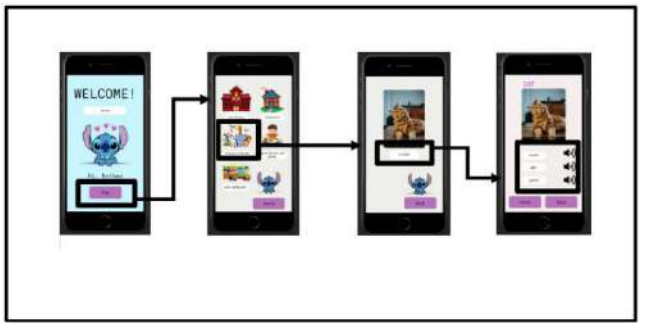

Figure 4 . Overall Application Process

This is the first object detection application introduced to read and display the name of the detected object in all three native languages (English, Sinhala, and Tamil) used in Sri Lanka, specialized for early childhood education. The below given diagram illustrate the simple design process of the application.

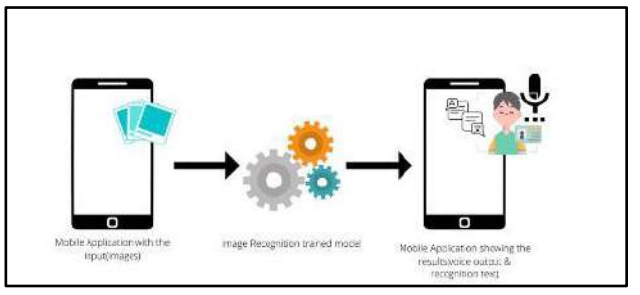

Figure 1. Overall Design Diagram

The application is developed in three different phases; namely the presentation layer, application layer and the machine learning layer. The machine learning layer works on image processing with the datasets fed into the operation. The datasets are then processed and divided into training sets, validating sets and testing sets. While the training and validating datasets are used in developing and training the model the testing data set evaluate the model where the final prediction model was developed. This process was continued with the animal, fruits and vegetable datasets while the numbers, letters and things around us datasets were simple trained using the YOLO (You Only Look Once) algorithm which is commonly used in CNN (Convolutional Neural Network)developments. CNN models were trained using Keras and Tensorflow libraries using GPU on Jupyter Notebook. Each category is comprised with 80+ classes giving the user a vast range of selections on the detection process. The application layer of the proposed system is built upon a Kivy based front end using python with a text-to-speech and translation collaborations using python libraries googletrans and gTTS(Google Text-to-Speech) . This layer will send the captured image through a pre-processor to the prediction model and recognize the image. This process will take the image through filters, pooling,fully connected layers(FC) and apply Softmax function to classify an object. After that a speech synthesizer will map the word to speech using a text-to-speech(TTS) system. For the development gTTs is used as it gives more native pronunciations where children can get the right interpretation of the voice context related to the region. The application layer or the user level is easy to use; userser-friendly mobile application where the learning and teaching process simple and organized. The below given is the overall physical diagram of the system.

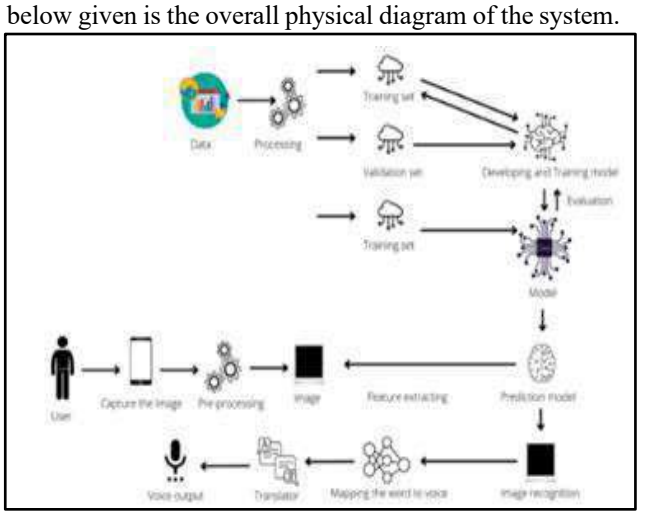

Figure 2. Overall Physical Diagram

4. .Results

This can detect and recognize various categories relevant to the learning and teaching process of early childhood education in day-to-day surroundings such as animals, fruits, vegetables etc. This provides the output on all three native languages in Sri Lanka with audio and textual representations which are highly accurate.Below given table shows the accuracy of the trained models(animals and fruits) which have high accuracy rates.The each individually trained model contained around 20000+ images and 6000+ images with 80+ classes for the testing process where Tensorflow and keras was used in training the model.

Table 1. Results of the trained dataset

Animal Dataset	Trained 22566 images with 80 classes	The model was trained for 16 epochs with 176 per step The final accuracy of the model is 0.6130 with a loss of 0.7652 The validation accuracy of the model is 0.5 with a loss of validation loss of 0.8776
Fruit Dataset	Trained 67692 images with 131 classes	The model was trained for 16 epochs with 528 per step The final accuracy of the model is 0.9947 with a loss of 0.1335 The validation accuracy of the model is 0.9779 with a loss of validation loss of 0.8255
Vegetable Dataset	Trained 15000 images with 15 classes	The model was trained for 5 epochs with 235 per step The final accuracy of the model is 0.9899 with a loss of 0.0318 The validation accuracy of the model is 0.9950 with a loss of validation loss of 0.0172

In this paper the system designed is an object detection system using deep learning object recognition techniques and voice outputs. The system's voice output feature provides a convenience feature for all the users who use different languages. As education sector is one of the areas where deep learning technologies can be applied this development was done for performance testing.

A. Advantages

Computerized flashcards always provide a simple way for students to study and learn with better interactions. With modern technology, kids can learn anytime at anywhere, with the computerization of flashcards. The output in all three native languages give the exposer to the languages used inside the country at a very young age; where the language barriers will be dissolved inside the country.These systems can give instant feedback and reactions than a familiar physical environment where teachers or parents use traditional flashcards. Spaced rehearsal is used in memorizing facts; in conventional teaching methods, the same will have a different effect when repeated by a person, but when computerized, the same thing will be repeated exactly as it was said before. The computerization of flashcards offers movement and multi-dimensional perspectives that will reach students, the visual learners. The main advantage is the kids' massive opportunity by exposing themselves to technology at a very early stage. This process and practice will take them to much better options in their future lives, as the world is moving much faster with technology. The process will teach them ups, downs, and limitations with the experiences most people are lacking.

B. Disadvantages

The most common issue is that even though technology seems to be prevalent globally, not all kids have access to computers, tabs, or mobile devices. Internet facilities are another major drawback that stops the spread of users. Some parents and teachers have both the facilities but lack the knowledge on operating. Most of them are scared to experience the change and only seem to believe in most of society's negativity. Setting up the environments for their kids with limited screen time and overseeing their work is sometimes challenging with the busy lifestyles of the modern parenting styles. One of the significant adversity is that overscreen timing can mix up the real world with a fantasy created by the emotions and feelings of the kids with their age.

5. Conclusion

The weaknesses and limitations in traditional flashcards and the current need of an online platform for children in their early childhood prove that there should be a further developed and an advanced application. The above discussed system will address all the issues with practical and modern methodologies. The below given table shows how the new application will address the limitations in the current flashcard systems with regard to the advanced introduced methodology.

Table 2. Advancements in the proposed system

Application	**Limitations**	**What the new application Provide?**
Virtual Flashcards(Azabdaftari and Mozaheb, 2012)	Offer users the necessary information such as words, images, pronunciations, animations, and videos but the scope is not specialized for children	1. The scope is specialized for early childhood education 2. Pronunciation is limited to English
AR Flashcards(Azabdaftari and Mozaheb, 2012)	Mix-up of real-world and fantasy it creates	1.User friendly and easy use, simple application
Orboot app(Tamayo, Gaviria and Rivas, 2016)	An AR application which can mix up the fantasy they create with the real world	1.User friendly and easy use, simple application
Wonderbook(Amalia, 2018)	Offer users to learn spelling of words properly. Limited to spelling learning process	1. Help learning word with visual representations 2. Provide spellings in three languages (Sinhala, English and Tamil)
themesforfun.com(Amalia, 2018)	Free printable English flashcards of how I grow- Day and Night theme flashcards limited to 25 cards	1.Not limited to a certain number of uploads for detection
customizedplayingcards.com(Byrd and Lansing, no date)	language education flashcards teaching the children or students new words. A word on one side and a picture the picture to be recognized on the other side. Lack the proper pronunciation	1.Support kids with proper pronunciation in Sinhala, Tamil and English
printerest.com (Byrd and Lansing, no date)	This application helps to improve the reading skills of children. "Guide" mode represents the flashcards, while the "Type" mode allows checking spellings. Complex operations	1.Easy and user-friendly operations
stemcellforautism.com(Byrd and Lansing, no date)	Specialized in representing emotions where positivity, as well as feeling and emotions, are taught. Limited to a one composition	1.Not limited to one area but include specialized areas in developing early childhood education
printrest.com(Good Manners Flashcards)(Amalia, 2018)	These flashcards make the kids name ways to be kind, show love to family, and be a helper. Limited to one composition	1.Not limited to one area but include specialized areas according to the NIE Syllabus

This application can be used widely to provide education to children in their day-to-day life. This is also expected to be used in preschools and daycare centers. In further developments of this system more selection options and exercised-based knowledge-gaining activities are to be implemented. This help in overcoming the threat of not having knowledge on technology with the fast development of the world and the phase drops in education due to the situations we face as a country. As the mobile devices are easy to use and portable this will help to detect objects from the surroundings and give voice outputs. Thus, education is the only path to develop through a life crises. Let us add a bit of technology to make it more effective, efficient, and valuable.

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