



# Augmented Reality-Based Elementary Level Education for Bengali Character Familiarization

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## Abstract

Augmented reality is widely used technology in current years in different field of education to enhance the learning process. This study reflects a new way to learn Bengali letters and digits for the early age primary school going children using AR technology. Nowadays, smart phones are very much available in Bangladesh from the rural area to urban area. The proposed method helps to observe interactive 3D view of the characters using mobile camera-based AR application having different options to learn how to write the target image character, the pronunciations process and the word making using the target letter. The target images was taken from the book pages provided by national curriculum and textbook board of Bangladesh to ensure the physical book available. This study focused on help the children in learning the Bengali letters and digits in more interactive, realistic and interesting way rather than the traditional manner. The process designed depending on marker-based AR technology which is feasibly strong for the early childhood education. Usability test results present in later portion. According to the survey, the major findings of the study that the teachers thinks the study reflects a positive way of making the learning process more engaging and as reported by assessment student performance increased using proposed AR method.

**Keywords** Augmented reality · Bengali letters and numbers · Elementary level education

## Introduction

AR is not only influences the researcher but also the educator because of its liveliness and interactive way of teaching. The AR features make the physical book more understandable and upgrade the learning experience. It removes the difficulties to realize the complex topics easily which overcome the challenges of conventional learning system. It helps the teachers to visualize the study materials to the student using 3D diagrams and animations including sounds. New dimension of teaching learning process introduced by incorporating the current technologies like AR which added more opportunity in quality education [8].

In recent years, children are very much interested to play using smartphone for entertainment purpose. This study incorporates the digital learning process using an

AR-based mobile application. Children will able to interact with virtual 3D objects to manipulate the video about the letter writing process, the audio of the pronunciation and able to see a word using the target letter. 3D characters make the students more engaging to the learning process and help to learn in a playful environment which is commonly used in Bangladeshi pre-schools by making 3D characters using wooden material or hard paper materials which influences the proposed work to use 3D letters and words in AR application. In [1], the study shows the feasibility of using the augmented reality for elementary level education which demonstrates AR become a remarkable tool for new teaching system and going to be more recognized. In [22], the study applied AR in tertiary level education to make the history lesson easier and give better idea about history of seventeenth century based on a city where they named the application Enredamadrid and the students found the use of the application most interesting. A review study in [11] illustrates the learning impact from the virtual world where they discussed the relate ability of AR in childhood education and keep suggestions for the AR designers. AR-based picture book familiarized for preschool students in [12, 13]. Notable story of the

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thirsty crow which is broadly used in early childhood education presented through Mobile AR application in [13], additionally, they motivate others to incorporate more AR application by observing the student feedback which was bilateral, cheerful and enjoying. In [12], total of 92 students of age between five and six was experimented to see the reflection of using Augmented Reality Picture Books (ARPB) where reflection of perception was marked as “very happy” which was the maximum factor of the range between very unhappy (1) and very happy (5). Butterfly’s ecology system was teach in an elementary school to the 60 students who studied in fourth grade, came to learn experimentally the butterfly lifecycle using AR mobile application where the evaluation shows this technology helps them to learn more effectively [24].

Intention of this study is to create a new dimension to enhance the Bengali characters learning process by merging the physical book and AR application. The study demonstrates the related work done earlier, the proposed method followed by the result evaluation. Later part represents conclusion summary.

## Background Study

### Augmented Reality

Diversity of virtual environment (VE) or virtual reality is marked as augmented reality in [14] where it provides a mock dimension of real world with virtual object. Moreover, the objects represented in three dimension, which creates an intermediate ground between virtual context and real world. The study prescribe any work using AR have three aspects noted as:

- i. Associate the real and virtual world
- ii. Interactional in real time
- iii. Three-dimensional registration

Integration of natural and virtual environment helps to get the digital content and proper view of the component on demand [15]. In [16], they mentioned to incorporate the sound with 3D graphics to enhance the experience of using augmented environment. AR can utilize using mobile phone devices, smart wearable glasses and display which are interactional [17]. Most of the study which were done earlier incorporating augmented reality was expensive using Head Mounted Display (HDM), display based on desktop monitor with additional camera and handheld display [20, 21]. Natural feature tracking used in augmented reality to detect the natural features of

video images which allowed to select point and regions features automatically and adaptably [25]. In current age, the study becomes more affordable by the help of Mobile Augmented Reality (MAR) with required facilities.

### AR in Different Fields

Tourist experience also take the advantage of AR technology. Important information like the navigation which helps to get hotel reservation, adjacent attractive destination and airline schedules close at hand are engaging using AR [7].

An audio-based augmented reality system introduced for the museum visitors in [5] where content personalization used as a key feature to enhance the experience of interaction. Here, they implement a system utilizing visitor behavior, interest, movement and head rotation with Sound Augmented Reality Interface for visiting Museum (SARIM) device which replace the manual interaction process. In [6], the study was looking for the new dimensions of AR technology by interviewing 15 tourism experts focused on 5 factors (marketing, economic, tourist, epistemic and organizational) and sort out the strategy of AR design to enhance tourist experience.

In current days, AR can play a vital rule in brand marketing as well [17], the study shows the potential of this technology where they suggested to utilize the capability using mobile AR app. A survey conducted on most downloaded mobile AR game Pokémon Go in [18] where they wants to crack down the reason behind getting such attention and noted as the flow of the game having social norms and the virtual representation of creatures perceived using mobile AR.

### Education Using AR

There are a number of study done earlier using AR for the betterment of education in different field of early childhood education and higher level of education like physics [2], chemistry [10], medical science [4], history [22]. Based on those studies, the proposed method started to promote the interactive study material using AR in primary level of Bangla studies.

In [2], they build three books to teach electromagnetism concepts of physics to the secondary school students. Diagrams with corresponding topics used which are considered as marker for the AR book. To brief how the dc motors works, simultaneously introducing the concepts of magnets, electromagnets and effect of magnetic field on a current carrying wire using different 3D figures via AR.

Hundred students from seventh grade of two different school was tested in [9], to teach Solar system details where students were found very much pleased and show interest to continue the learning process using AR

applications. Besides, the academic accomplishment and the student attitude appeared positive and noteworthy. Augmented Reality Teaching Platform (ARTP) introduced in [10] where periodic table of atoms constructed using colored ball which have independent electron layer and charges of nucleus, in addition explained the atomic bond using AR to teach chemistry to the secondary school students to create a better learning environment. To influence the children in recycling, an AR-based game was experimented on 38 children in [23] where the study found the game create positive motive to change attitude by learning recycling topic more enjoyable way. AR-based story books designed for the children aged between 6 and 7 in [3] which helps the child to recall the events easily as they can see the interesting part of the story visually. Besides, it creates more interest to children as it became interactive and keeps the children more engaged.

Acceptance and demand of mobile technology is rising tremendously. Besides, AR using mobile phone or tablets which named as Mobile Augmented Reality (MAR) getting a good place in educational enhancement [8]. The study elaborates the positive effect and empowering result of many other studies done earlier using MAR. They advised to incorporate the traditional teaching learning process as the quality enhancement of the topics relies on the design of AR.

In [11], the study advocates the robustness of the application of AR in childhood education. The study describes, it can consider more child attention via virtual representation and minimize the discrepancy between the schooling and context. According to [12, 13], AR presents magical role in preschool education.

In [19], the study also introduced the Bengali vowels of alphabet learning process using MAR. They printed the characters in large font and create 3D characters of that particular character and a picture of a character which represents word making of characters by recognizing printed letters. They added rhyme to improve the

memorizing ability of the students. Table 1 enlists different models used to enhance the education system using AR technology.

This study was focused on the book available to the people in large numbers. The proposed system used the target images as marker which are collected from National Curriculum and Textbook Board (NCTB) of Bangladesh provided text books which is available to the students of rural to urban areas as those books are freely served by the government. Additionally, the method includes the number system learning process with their spelling, pronunciation and way of writing.

## Methodology

Bangla alphabet has two types of letters, vowel which is known as “swara-barna” and consonant which is familiar as “banjan-barna”. In vowel, there are 11 letters and 39 characters are in consonant. Besides, number system have ten digits.

The implementation was done using android based mobile application. Mobile camera will appear in the interface by opening the app. The AR camera search for the target image to generate augmented output. Natural feature-based tracking (Fig. 1) is used in Vuforia engine to detect the target image which provide the ratings of being augmentable for the database images. The recognition of the character is done by comparing the feature points available in the database image and AR camera image. After successful image recognition, it will show the features which include three additional icons in the screen along with the 3D character. By moving the camera from the target image to other area, the augmented features will not be available anymore.

## System Design

In this proposed method, Blender was used to generate 3D models of Bengali characters. To deal with Bengali

**Table 1** Difference with other proposed model using AR for the betterment of education

References	Proposed AR design
[2]	To teach lectromagnetism to the secondary school students by creating own AR book and a handheld AR device to view
[9]	Planets were visualized by 3D models to teach solar system to the 7th grade school students using AR based booklet
[10]	Augmented reality teaching platform (ARTP) introduced to demonstrate the periodic table of chemistry including the atom structure to the middle school students
[3]	Story telling AR book for the primary school students to explain the story using correct technology
[19]	Using android based AR application to familiarize the Bengali letters by picture and rhyme to the 3–5-year children by recognizing letters from own printed papers
Our proposed method	Using android-based AR application by recognizing characters including the number system from the book provided by National Curriculum and Textbook Board which includes the word making, pronunciation, letter writing technique and 3D letter





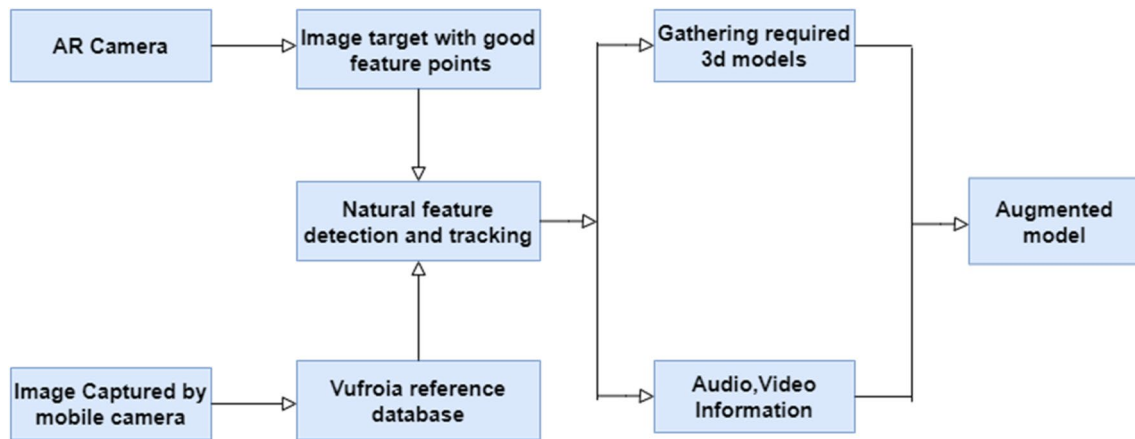


Fig. 2 The proposed method work flow

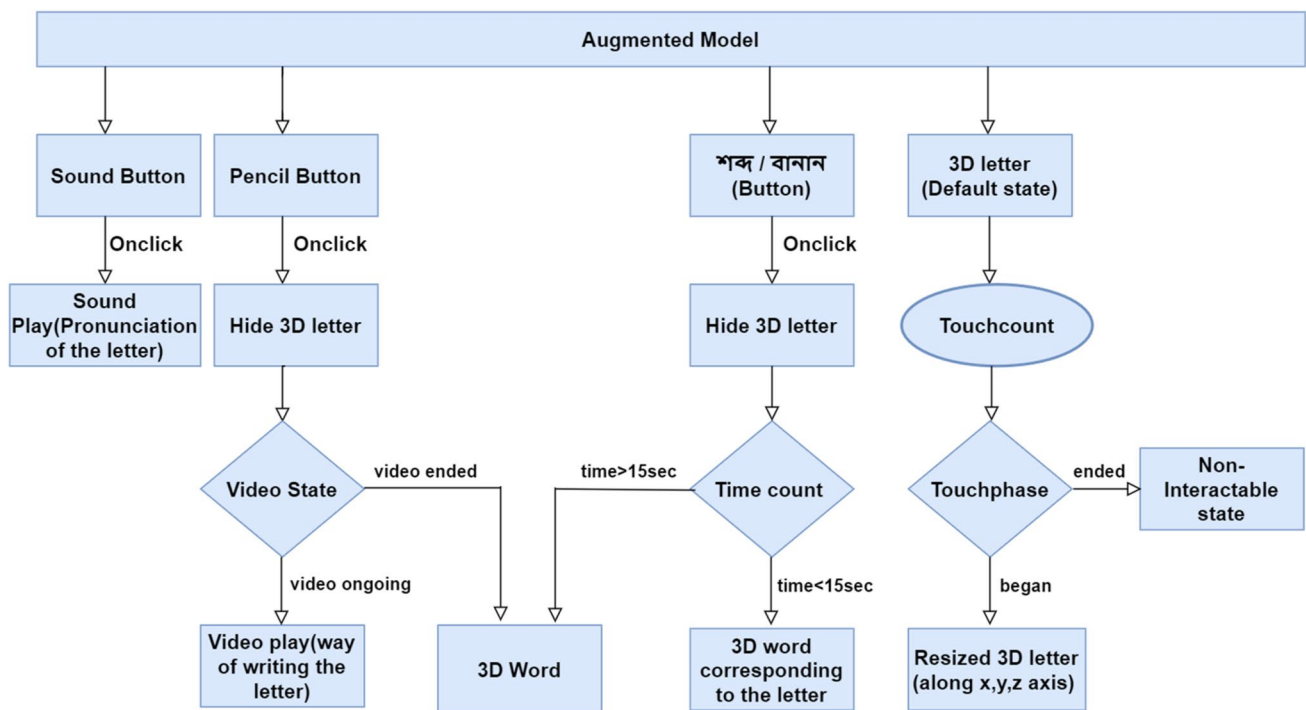


Fig. 3 Interactive model of the augmented components

using marked character appeared using the icon written in Bengali “Shob-da”, the way of writing the character of that particular character will come out by clicking on the pencil icon. Besides, by pressing the sound icon pronunciations of the characters played. The icons can be used multiple times till the marker is present.

For the number system, a Bengali word “Banan” take place instead of “shob-da” to learn the spelling of the particular number. The Bengali writing font “kalpurush” used throughout the work as it represents the precise structure of Bengali characters.

In Fig. 4, by pressing the pencil icon a video appeared where the way of writing a character presented using a Bengali vowel character “rosh-ow-e”. The word marking using a consonant character of Bengali alphabet “ko” showed in Fig. 5, during this time the 3D view of the character disappeared. The interface after successful marking in Fig. 6 for the number system, “banan” was used instead of “shob-da”. A sample number of Bangla number system “shat” displayed in Fig. 6 which is equivalent to seven in English.



Fig. 4 Letter writing process using a Bengali vowel



Fig. 6 3D model of a number from Bengali number system

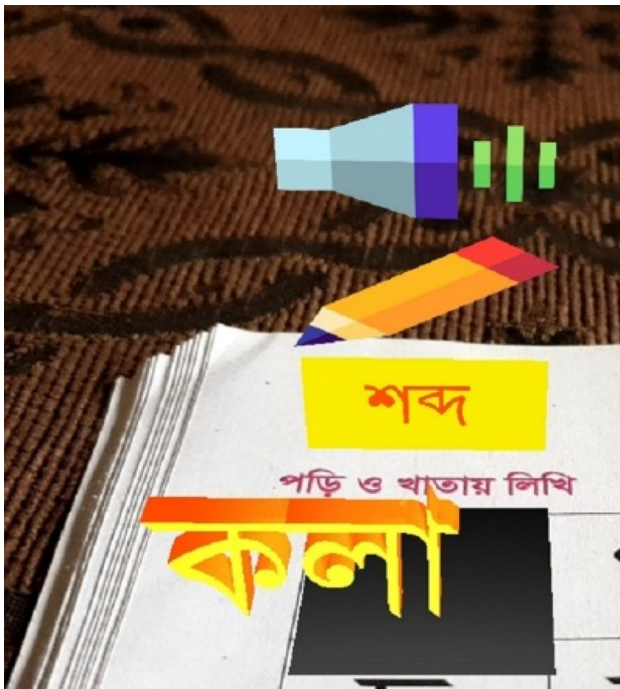


Fig. 5 Word marking using a Bengali consonant

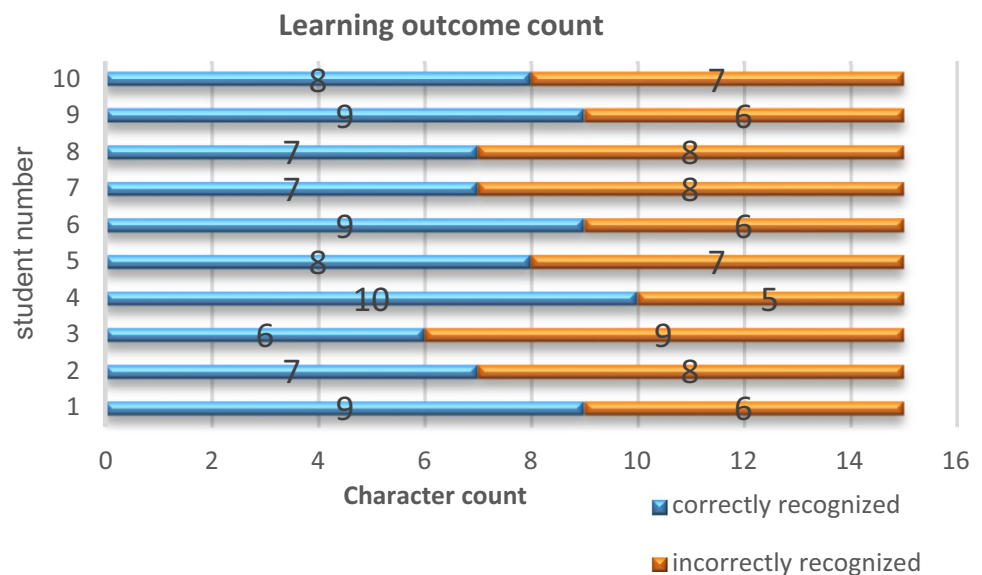
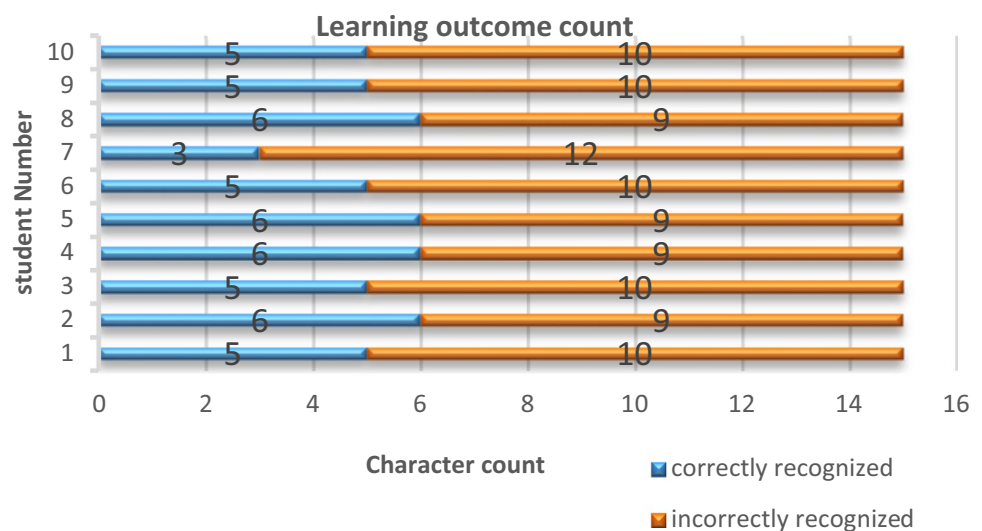
## Result Evaluation

A survey was conducted from thirty elementary level teachers who teach the early age students in primary school or in house about their experience to use the proposed system where 90% of the teachers, 16 of them agreed and 11 of them strongly agreed to found the proposed system will improve the learning process of Bengali alphabet and number system. The teachers appreciated incorporating technology in primary level teaching and found it applicable in their comments. Table 2 shows the questionnaires and feedback from the participants of the survey.

In Table 2, the survey questionnaires had five options for feedback which were strongly disagree, disagree, neutral, agree and strongly agree. The percentages of feedback given out of 30 and the count is given under bracket. Using augmented reality in elementary school is acceptable and is a positive sign was reported by 26 teachers where 16 of them were agreed and 10 of them are strongly agreed. Besides all the teachers found the learning process interesting as the 3D structures are interactive where 46.7% of them were agreed and 53.3% were strongly agreed. Almost half of the educators thinks that, they need not to memorize a lot of thing to operate the system where 7 of them were strongly disagreed and 7 of them disagreed, other 16 were neutral. Markers can recognize the target smoothly was found by 25 teachers where 18 of them agreed, 7 of them strongly agreed and 4 of them was neutral.

**Table 2** Survey questionnaires with feedback on overall system performance and application of AR in early age education

Survey question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The proposed system enhances the learning quality of Bengali characters	0% (0)	0% (0)	10% (3)	53.3% (16)	36.7% (11)
The system interface is convenient and user friendly	0% (0)	0% (0)	6.7% (2)	50% (15)	43.3% (13)
The orientation of the icons are flexible and understandable for the user	0% (0)	0% (0)	10% (3)	46.7% (14)	43.3% (13)
The 3D interactive character (size increase and decrease) makes the learning process interesting	0% (0)	0% (0)	0% (0)	46.7% (14)	53.3% (16)
Markers are recognized by the system accordingly	3.3% (1)	0% (0)	13.3% (4)	60% (18)	23.3% (7)
Need to memorize many things to operate the system	23.3% (7)	23.3% (7)	53.3% (16)	0% (0)	0% (0)
Incorporating the AR technology in early age education is a good concept	0% (0)	6.7% (2)	6.7% (2)	53.3% (16)	33.3% (10)
The system will work as a teacher for the children which helps to learn the letters and their use with less effort	0% (0)	0% (0)	3.3% (1)	43.3% (13)	53.3% (16)

**Fig. 7** Assessment result of the students using proposed AR system in character learning**Fig. 8** Assessment result of the students did not use proposed system in character learning

Moreover, an experimental study was taken on 20 students from an elementary school named “Hello kids” of Sylhet. Ten of them learn the alphabet and number system for 10 days using the proposed AR system and others were teach in traditional way. To find the learning outcome from both way five Bengali vowels, seven consonants and three numbers were tested to recognize randomly for each of the student. Figures 7 and 8 reflect the individual performance of the students in character recognition. The students using AR application recognized 8 characters correctly on average out of 15 and 5.2 characters were identified by the students learn in traditional manner.

## Conclusion

Bangla is widely used language and over 260 million people used this language for regular communication. The study will help the early age child and people from different language to get familiarize with Bengali characters. Besides from the teachers view, the system will play a unique rule to learn the characters playfully. Likewise students found the learning technique easy and enjoyable. Although using the 3D letters may create confusion about the structure of the letters sometime, most of the case it makes the learning process more engaging. The proposed method works smoothly in good light condition as marker need to match the target image perfectly. Besides the surface of the image target need to be plain, moreover target image required enough feature points to track using AR camera and image needs to be rich in details with good contrast. In addition, the augmented model is restricted to show one character information at a time to reduce the confusion of early age children. The study shows the way of distance learning by implementing different AR book by which the people lives in hill tracks or underdeveloped area with smartphone can make the early childhood learning interesting for their future generation.

## Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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