
Feasibility Report

for

Augmented Reality in Education

Version <1.2>

Section -A, Group-2

Serial	Name	Student ID	Email
01	Pratyusha Kundu	201814014	pkdroide@gmail.com
02	Anika Zaman	201814018	anikazaman5470@gmail.com
03	Zannatul Ferdous	201814024	zannatul207@gmail.com
04	Rabeya Akhter	201814025	rabeyani2@gmail.com
05	Shobnom Mustary	201814028	shobnomshuvra28@gmail.com
06	Anika Tahsin	201814038	anika.t09@gmail.com

Submitted To: Lt Col Nazrul Islam, PhD, Sigs

AP Nuzhat Tabassum

Lec Muhaimin Bin Munir

Lec Nafiz Imtiaz Khan

Lec Md. Mushfiqur Rahman

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Development Sessional

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Revisions

Version	Primary Authors	Description of Version	Date Completed
Version 1.1	Group – A2	<ul style="list-style-type: none">• Introduction• Present System• Proposed candidate systems• Best candidate system• Present vs proposed system The information is submitted separately.	30/01/2021
Version 2.1	Group – A2	<ul style="list-style-type: none">• Tabular representation of candidate system• Information gathering is added.• Characteristics of proposed candidate system with DFD	22/05/2021

ABSTRACT/EXECUTIVE SUMMARY

Technology in education can influence students to learn actively and can motivate them, leading to an effective process of learning. Augmented Reality (AR) in education features aspects that enhance learning of abilities like problem-solving, collaboration, and creation to better prepare students for the future. The name of the project stands as “Augmented Reality in Education”. The objective of augmented reality in education is to build environments with a high degree of participation and interactivity, in which the student is able to build, design, modify, experiment and become much more actively involved in the learning process. Augmented Reality is a new medium, combining aspects from ubiquitous computing, tangible computing, and social computing. This medium offers unique affordances, combining physical and virtual worlds, with continuous and implicit user control of the point of view and interactivity. Through information gathering we have scrutinized the existing system and found out the feebleness in the evaluation method. Two candidate system as “An AR based app to show a video related to study topic” and “An AR based app to help a student to know about the meaning and pronunciation of a word” have been proposed. Furthermore, both of them have been analyzed on the basis of system Characteristics, Qualitative Evaluation Matrix, Performance & Cost Evaluation Matrix and Weighted Evaluation Matrix. Through the detailed valuation procedure, the best candidate system has been proposed in this document.

Key terms: Augmented Reality, Mobile App, Smart Glass, Education.

1 Introduction

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information. AR can be defined as a system that incorporates three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects. This experience is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment. The primary value of augmented reality is the manner in which components of the digital world blend into a person's perception of the real world, not as a simple display of data, but through the integration of immersive sensations, which are perceived as natural parts of an environment. The future of augmented reality is getting evident in various industries. Traveling, gaming, media, marketing, education, and entertainment are some of the major sectors where this one of the latest technology trends is creating an impact. Augmented reality (AR) aims to present information that is directly registered to the physical environment. AR goes beyond mobile computing in that it bridges the gap between virtual world and real world, both spatially and cognitively. With AR, the digital information appears to become part of the real world, at least in the user's perception.

The combination of AR technology with the educational content creates new type of automated applications and acts to enhance the effectiveness and attractiveness of teaching and learning for students in real life scenarios. Interactive, gamified AR learning can have a significant positive impact on students. It keeps them engaged throughout the lesson and makes learning fun and effortless. Augmented reality apps offer vast opportunities to diversify and shake up boring classes. Interactive lessons, where all students are involved in the learning process at the same time, help improve teamwork skills. Augmented reality has the potential to replace paper textbooks, physical models, posters, printed manuals. It offers portable and less expensive learning materials. As a result, education becomes more accessible and mobile. AR in education helps students achieve better results through visualization and full immersion in the subject matter. A picture is worth a thousand words so, instead of reading theory about something, students can see it with their own eyes, in action. Augmented reality can help make classes more interactive and allow learners to focus more on practice instead of just theory. As AR adds virtual objects to the real world, it lets students train skills using physical devices.

Augmented reality also has a lot of potential in the gathering and sharing of tacit knowledge. Augmentation techniques are typically performed in real time and in semantic contexts with environmental elements.

2 EXISTING SYSTEMS

2.1 INFORMATION GATHERING AND ANALYSIS

2.1.1 Overview & Objectives

Augmented reality in education can serve a number of purposes. It helps students easily acquire, process, and remember information. Additionally, AR makes learning itself more engaging and fun.

The objectives of introducing Augmented Reality in our educational system are:

- **Accessible learning materials: anytime, anywhere.**

Augmented reality has the potential to replace paper textbooks, physical models, posters, printed manuals, etc. It offers portable and less expensive learning materials. As a result, education becomes more accessible and mobile.

- **Higher student engagement and interest.**

Interactive AR learning can have a significant positive impact on students. It keeps them engaged throughout the lesson and makes learning fun and effortless.

- **Improved collaboration capabilities.**

Augmented reality apps offer vast opportunities to diversify and shake up boring classes. Interactive lessons, where all students are involved in the learning process at the same time, help improve teamwork skills.

- **A faster and more effective learning process.**

AR in education helps students achieve better results through visualization and full immersion in the subject matter. So, instead of reading theory about something, students can see it with their own eyes, in action.

It is also not limited to a single age group or level of education and can be used equally well in all levels of schooling: from pre-school education up to college.

2.1.2 Information Required for System Analysis

Information's are required to conduct a feasibility study and proper use of the information can lead us to a proper advancement of our education system. The information which are required are the present state of using technology in our education system, the advanced method which can be implemented using existing technology and difficulties faced by both students and teachers which can be solved by introducing Augmented Reality in our education system.

Information needed

- a. How efficient is our current education system?
- b. Coping mechanism for the difficulties while studying.
- c. How the performance of the existing system can be enhanced?
- d. How the teachers are teaching critical topics at present?
- e. Current privileges to have access to technology.
- f. How familiar the Augmented Reality method is?
- g. What kind of devices is preferable for Augmented Reality?
- h. How does AR help in education?

2.1.3 The Sources of Information

As being a project related to our education system the sources are basically the students, teachers and guardians.

At first, we gathered information from the students of secondary and higher secondary level through questionnaire about their regular struggles while studying, how much they need help outside the textbooks etc. We also confirmed if they have access to smartphones at home. We also gathered information from the guardians of students if they are comfortable enough to let their children use internet for study purposes, their current privileges to have access to technology and their familiarity about Augmented Reality.

We have interviewed some key personnel of Ministry of Education through structured and unstructured way. We gathered information about the measures education ministry has already taken to digitalize our education system and the future plan to introduce Augmented Reality in education system.

2.1.4 Information Gathering Methodology

Ser.	Information Needed	Source	Method	Outcome
1	How efficient is our current education system compared? (I1)	Students(S1)	Questionnaire(M1)	Most students are dissatisfied with current education system.(O1)
		Administration Personnel(S4)	Interview(M3)	While introducing new technology in our education system, the economic condition of a group of people should be taken in consideration which is not important in developed countries. (O2)
		School Teacher(S5)		The main difference is our education system is not mostly experiment based compared to the education system of developed countries. (O3)
2	Coping mechanism for the difficulties while studying.(I2)	Students(S1)	Questionnaire(M1)	Students browse Internet to solve their confusion while studying at home.(O4)
		Parents(S2)		Parents usually arrange for private tuition or suggest browsing the internet.(O5)
3	How the performance of the existing system can be enhanced?.(I3)	Students(S1)	Questionnaire(M3)	Students want internet based education system in classroom for better understanding.(O6)
		Online articles & research papers(S3)	Literature review(M2)	The advantages and beneficial uses of AR features are able to engage students in learning processes and help improve their visualization skills.(O7)

		Administration Personnel(S4)	Interview(M3)	To make our teaching system more practical, the technologies should be installed as a classroom or institutional feature so that the students do not have to afford individually.(O8)
		School Teacher(S5)		To make our education more practical some apparatus should be made using materials available in our country or a system should be made which can be used to have various real time experiences.(O9)
4	Current privileges to have access to technology.(I4)	Students(S1)	Questionnaire(M1)	Most of the students have access to smart devices and internet connection.(O10)
		Parents(S2)		Parents try to afford 3D devices for their child's education upon requirement and give them access to internet for study purpose.(O11)
5	How the teachers are teaching critical topics at present?(I5)	School Teacher(S5)	Interview(M3)	Due to the lack of experimental apparatus, the teachers try to explain different topics students using daily life examples.(O12)
6	How familiar the Augmented Reality method is?(I6)	Students(S1)	Questionnaire(M1)	Augmented Reality is not really popular among the students and parents.(O13)
		Parents(S2)		
7	What kind of devices is preferable for	Students(S1)	Questionnaire(M1)	Most students are comfortable using handheld devices.(O14)

	Augmented Reality?(I7)	Online articles & research papers(S3)	Literature review(M2)	See-through and Monitor-based displays are two major types of displays used in augmented reality.(O15)
8	How does AR help in education?(I8)	Online articles & research papers(S3)	Literature review(M2)	Animation together with interesting data and an engaging presenter helps the audience understand the results of an analysis of information.(O16)

2.2 PRESENTING THE EXISTING SYSTEM

Though our country does not have AR based education system but in other countries AR is getting popular and it is used in many fields including education. In the existing systems, AR is applied to increase the outcome of learning in an effective way.

To analyze the existing AR implemented systems, we have reviewed two systems. The first one is the AR Book Application and the second one is the systems to learn foreign languages.

Our motive behind the analysis of these systems was to discover the lacking and deficiency and update or modify these features.

AR Book Application:

In this system, augmented reality was pertained through the books that will be printed with the actual photographs of the objects. The photographs contain brief depiction together with information regarding history or functions or utilities. At the moment, this system is implemented for Balinese artistic and cultural objects. The photograph of the object serves as marker or pointer individually. When the marker or pointer is detected, the system visualizes the respective three-dimensional object through the screen and an automated audio is played that reads what is written in the book. However this system does not provide any additional information or related statistics of the object. Moreover, the system cannot is not interactive with the user that is necessary for the system to function well according to augmented reality.

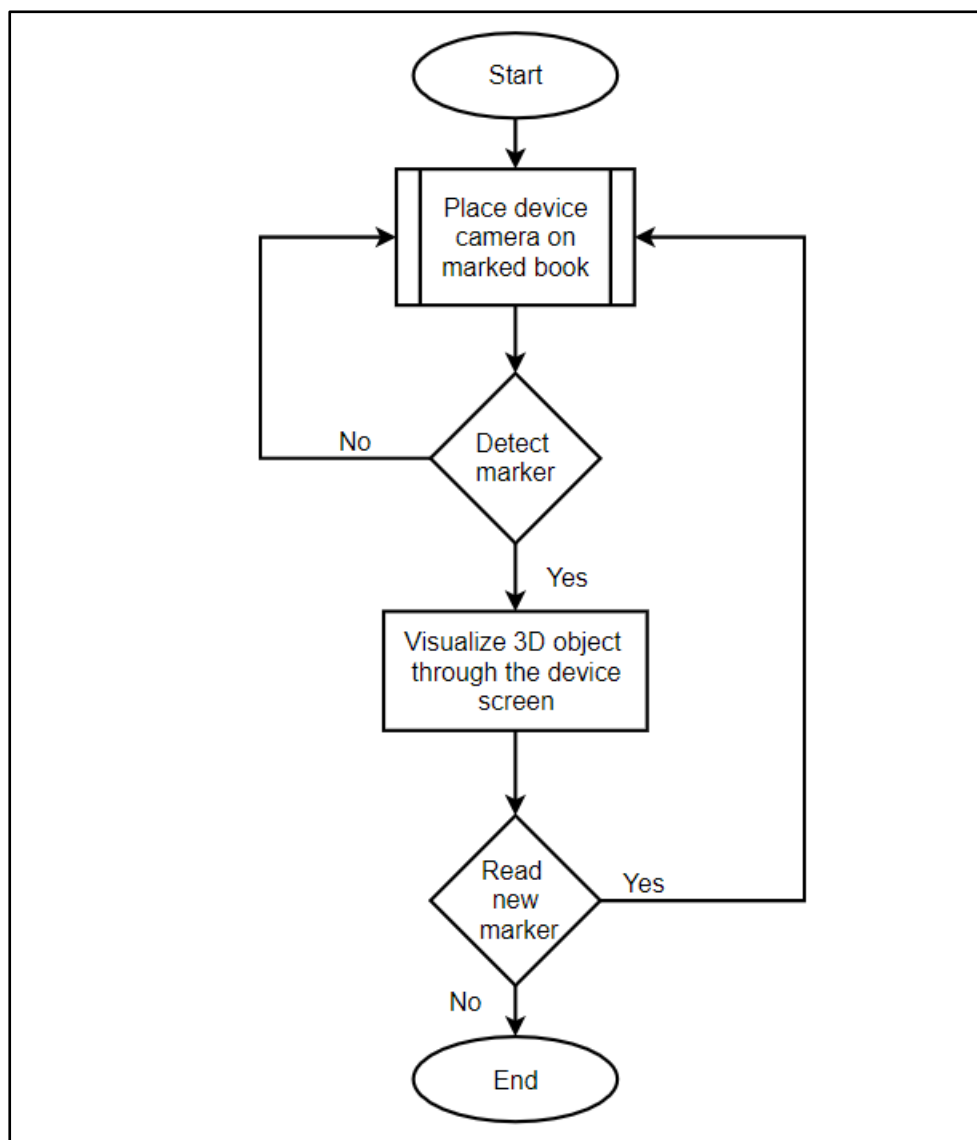


fig: Flowchart Diagram of AR Book Application

Language learning App (Duilingo):

This is a free language instructional system for learning over 35 languages through quick bite-sized lessons. Different kinds of features can be found such as grammar lessons, vocabulary cards, multiple choice questions and more. This language learning system primarily offers a free proficiency test to get a rough estimation of what the language skills of the user before getting started. Then it gives focus on the development of basic vocabulary, grammar and sentence structure as well as the learning of new words. After going through these lessons, it will take a lesson completion test and then focus on sentence formation via fill in the blank, direct sentence translation and matching words together. It also offers gamification experience. There is a feature called “chat bot” which helps the users to practice lessons. Nevertheless, Duolingo is not interactive which is not quite beneficial for the users. It is theoretically proven that the learning is effective and faster if the user can practice and interact with the system using what they have learnt. Furthermore, this does not provide any visualization to the user which is also a great way of remembering information longer. This system does not involve augmented reality in the process of learning.

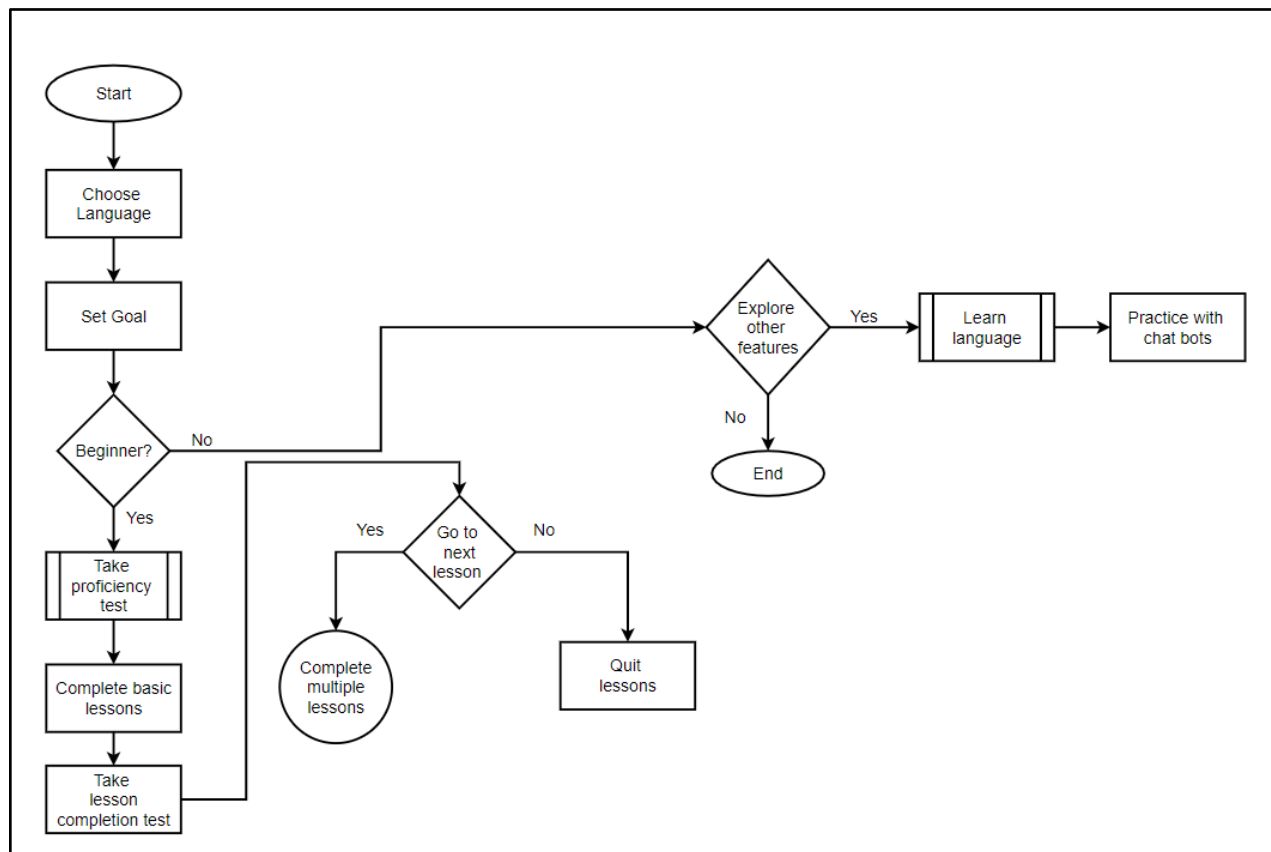


fig: Flowchart Diagram of Duolingo

Traditional Education System in Our Country:

1. Traditional chalk and talk teaching method and the use of static textbooks are failing to engage students and leading to poor learning outcomes.
2. The study of science is a complex process that includes identifying a problem, investigating the problem, making hypotheses, planning the data collection method, testing the hypotheses, collecting the data and making the conclusion and results. Our traditional education system often seems hard and boring due to the lack of proper representation of the actual concept.
3. Students are less interested in studying Science because of their perception that it is a boring subject involving too many abstract concepts.

In our country the education system is bookish and often students find it hard and boring. They find it hard to visualize things and fail to understand which is why they might not find science or any other subjects interesting. AR based education system can solve this problem. That is why we need to introduce the system to this field for proper understanding of the students as well as make it interesting.

3 Proposed Candidate Systems

3.1 Potential Candidate Systems

The candidate systems that we proposed are based off of the existing system where we have done major changes in the system. The systems will help the user to visualize the objects more dynamically along with getting the proper learning and knowledge of those.

The following candidate systems are capable of adapting the special features of augmented reality with the present systems. The systems will fulfill the requirements we have collected from the information gathering methodology (interviews, survey and questionnaires) since both the system provide dynamic visualization and an engaging presenter to the user. Following are the fetures of our candidate systems in the tabular form:

Candidate System	Features
Reformed AR Book Application	<ul style="list-style-type: none"> • The system will include illustrations with additional supplementary information that will be visible when the smartphone screen is hold in front of the book. • There will be photographs that will be marked and it will be displayed as three-dimensional virtual models in the smartphone. • When the smartphone is displaying the models there will be other required links provided such as Wikipedia, YouTube or Google links that will demonstrate the object or topic well. • The marker will also be able to work as a dictionary. There will be an option to select any word from the book through smartphone and the system will provide the meaning, synonym and antonyms of the word and sentences with them.
AR Based Language Learning System	<ul style="list-style-type: none"> • The system will be activated when the user will use a smart glass to create an augmented version of the environment. • The system will then work like an instructor or presenter to the user. • The system will be interactive with the user through various actions such as reading or listening. • The system will provide required virtual models and work as a dictionary that will be related to the words user is learning upon requirement • The required video and audio links will also be available in the native language so that the user can relate to the topic.

Table: HW and SW requirements of the candidate systems

Candidate System	Hardware	Software
Reformed AR Book Application(Candidate System C1)	Personal devices (Mobile, Personal Computers etc.) Storage like RAM or SD Card	AR based app making software(Unity) Database
AR Based Language Learning System(Candidate System C2)	Augmented reality supported glasses	AR based app making software(Unity) Database

3.2 Characteristics of the Candidate Systems

No	Characteristic	C1	C2
1.	Age group	Students	People of all age
2.	Google Text-to-speech	Not required	Required
3.	YouTube search engine API	Required	Required
4.	Dictionary API	Required	Required
5.	Voice output	Not required	Speakers, Microphone
6.	AR headset	Not required	Not required
7.	AR glasses	Not required	Required
8.	Database	Required	Required

3.3 Performance and Cost-Effectiveness of the Candidate Systems

3.3.1 Candidate System Performance/Cost Evaluation Matrix:

Evaluation Criteria	AR based app to show a video related to study topic (C1)	AR based system to help a student to know about the meaning and pronunciation of a word (C2)
Performance		
Accuracy of projecting objects	Very good	Excellent
Response Time	Fair	Fair
User Friendly	Excellent	Good
Reliability	Good	Good
Adaptability	Very Good	Need more concern
Battery Life	Longer lifespan	Short, often not replacable
AR quality	Good	Excellent
Cost		
Deployment Cost	8000tk. Approx.	25000tk. Approx.
User Training	Not Required	Required

As the performance and cost data might not always help to select the best choice, so a quantitative weighted rating is used to weight the importance of each criterion where we assigned some weight based on their necessity and we calculated the highest total weight for finding the best candidate system.

3.3.2 Weighted Candidate Evaluation Matrix:

Evaluation Criteria	Weighting Factor	AR Book Application (C1)		AR Based Language Learning System(C2)	
		Rating	Score	Rating	Score
Accuracy of projecting objects	5	4	20	5	25
Response Time	4	3	12	3	12
User Friendly	5	5	25	3	15
Reliability	4	3	12	3	12
Adaptability	5	5	25	3	15
Battery Life	4	4	16	2	8
AR quality	5	3	15	5	25
System Development Cost	5	5	25	3	15
User Training	3	3	9	2	6
			159		133

3.4 Selection of the Best Candidate Systems

Two candidate systems has been introduced here. .Among these two candidate systems in terms of performance candidate system C1 i.e. AR based app to show a video related to study topic is much more user friendly, adaptable than other candidate system.

Basis on Bangladesh education system, system development cost carries an important role in taking decision about candidate system. System development cost and user-training cost of candidate system C1 is less than other system. Therefore, candidate system with the highest score of 159 is selected as the best candidate system.

4 Specification of the Selected Candidate Systems

Functional & Non-Functional Requirements:

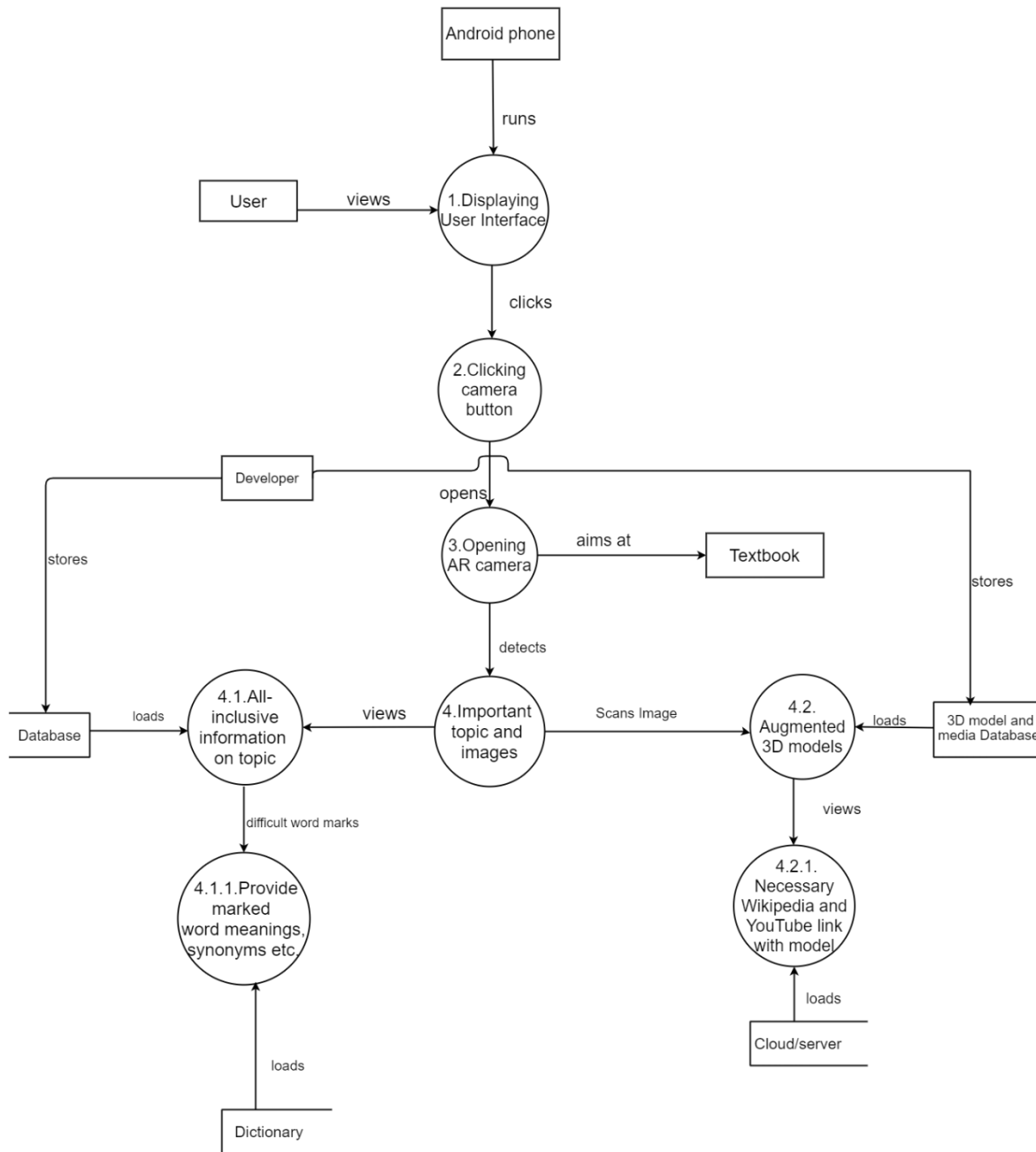
As we already selected the best candidate systems we need to discuss the User Requirements as well as Functional and Non-functional requirements of the systems.

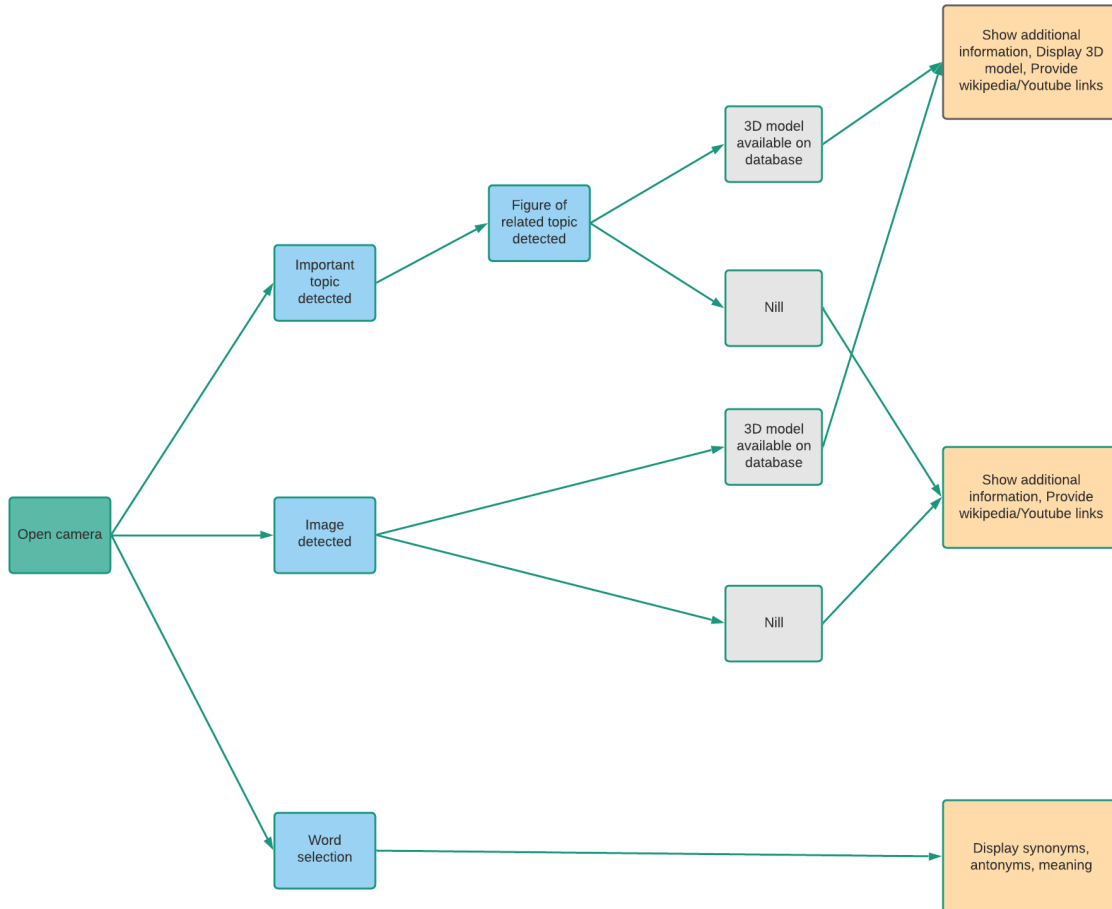
Functional Requirements:

1. **Accessing augmented reality:** Students will have the total control of the virtual world through their devices (smartphone, tablet etc). Students will click on to AR camera & aims in front of the text book, the system will show illustrations with additional supplementary information in augmented reality.
2. **Accessing Google/Youtube:** The smartphone will display the models with required links provided such as Wikipedia, YouTube or Google links that will demonstrate the object or topic well.
3. **Working as dictionary:** The marker will be able to work as a dictionary. There will be an option to select any word from the book and the system will provide the meaning, synonym and antonyms of the word and sentences with them.
4. **Learning with virtual 3D objects:** Students will improve their understanding of abstract, spatial geometric concepts through manipulation and multi-angle observation of virtual 3D objects. The system will allow students to experiment in a safer environment than handling the situation such as chemical in real life.

Non-Functional Requirements:

1. **Accessibility:** The system will be user friendly.
2. **Accuracy:** The system will show the accurate results of projecting objects.
3. **Security:** The system will be able to maintain the security of any sites & user's information.

Data Flow Diagram of selected candidate system:

Decision Tree of selected candidate system:

Decision Table of selected candidate system:

Condition Stub		Condition Entry					
IF		1	2	3	4	5	6
	Smartphone Camera is held in front of the book.	Y	Y	Y	Y	Y	Y
	Important topic is detected	Y	Y	Y	N	N	N
	Figure of related topic/ Any image is detected	N	Y	Y	Y	Y	N
	3D model of the figure is available on the database	N	N	Y	N	Y	N
	Any word is selected for better understanding	N	N	N	N	N	Y
THEN	Show additional information.	✓	✓	✓	✓	✓	
	Display 3D model of the figure on screen.			✓		✓	
	Provide Wikipedia/ Youtube video links		✓	✓	✓	✓	
	Display meaning, synonyms, antonyms etc for the marked word.						✓
Action Stub		Action Entry					

5 Conclusions

The goal of this feasibility study is to introduce a suitable augmented reality (AR) based system to our reigning education system to make learning easier, faster and more interesting. This has been done by researching, comparing and evaluating the current AR based education applications and tools and proposing two better candidate systems enhancing the features of those current systems. The best candidate system has been chosen from them by examining the evaluation matrices. To understand the structure of the selected system better, a proper data flow diagram along with a decision tree are provided. This study will lead us to design an advanced and more efficient AR based education system which will help the students to visualize and understand the bookish knowledge better.

Appendix A – References

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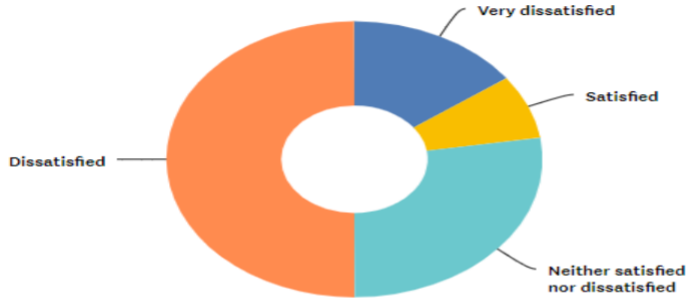
Appendix B – Questionnaire Sheets

Questionnaires for Students:

Some questions for students and their respective responses are attached below:

Are you satisfied with the learning process of traditional education system?

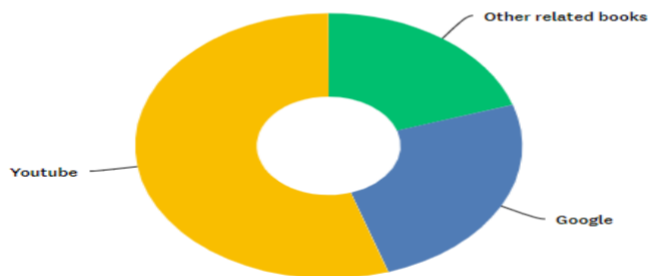
Answered: 40 Skipped: 0



ANSWER CHOICES	RESPONSES
Very satisfied	0.00% 0
Very dissatisfied	15.00% 6
Satisfied	7.50% 3
Neither satisfied nor dissatisfied	27.50% 11
Dissatisfied	50.00% 20
TOTAL	40

Which one do you prefer when you don't understand a topic while studying?

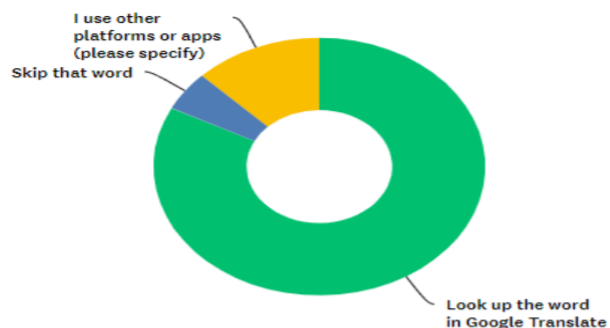
Answered: 40 Skipped: 0



ANSWER CHOICES	RESPONSES
Other related books	20.00% 8
Google	25.00% 10
Youtube	55.00% 22
TOTAL	40

What do you do when you don't know how to pronounce a word?

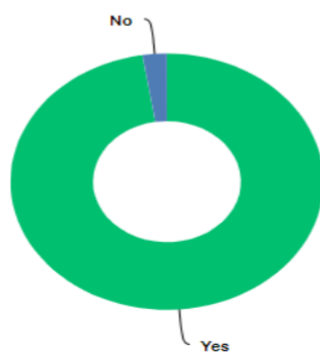
Answered: 40 Skipped: 0



ANSWER CHOICES		RESPONSES	
Look up the word in Google Translate		82.50%	33
Skip that word		5.00%	2
I use other platforms or apps (please specify)	Responses	12.50%	5
TOTAL			40

Do you have access to any electronic smart devices?

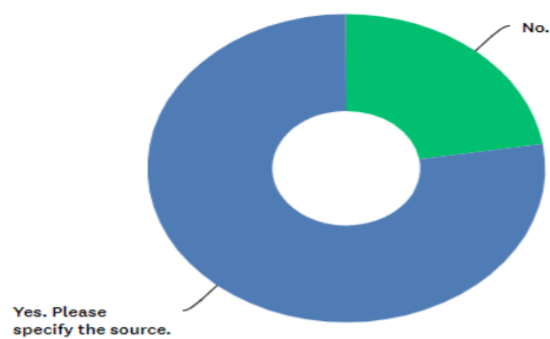
Answered: 40 Skipped: 0



ANSWER CHOICES		RESPONSES	
Yes		97.50%	39
No		2.50%	1
TOTAL			40

Is internet connection attainable in your area?

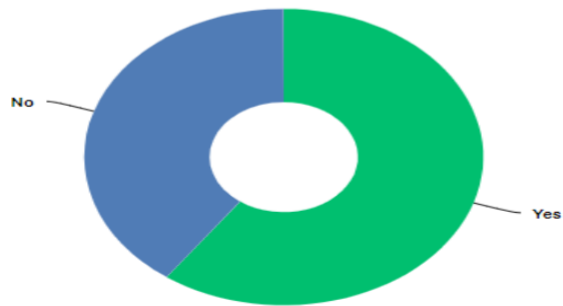
Answered: 40 Skipped: 0



ANSWER CHOICES		RESPONSES	
No.		22.50%	9
Yes. Please specify the source.	Responses	77.50%	31

Are you comfortable with carrying extra device to your institution?

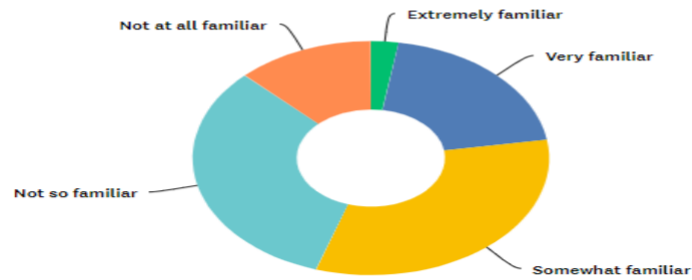
Answered: 40 Skipped: 0



ANSWER CHOICES		RESPONSES	
Yes		60.00%	24
No		40.00%	16
TOTAL			40

How familiar are you with the concept regarding Augmented Reality?

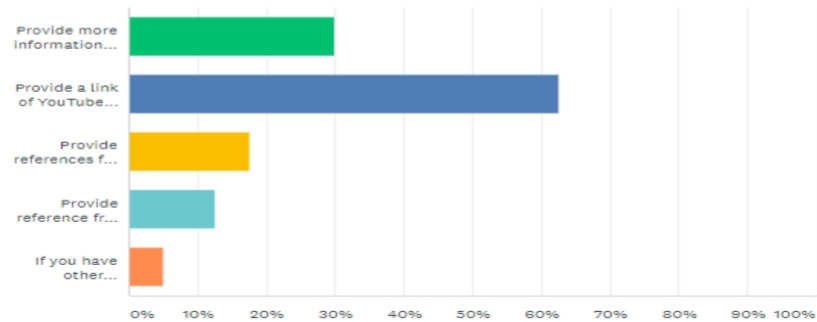
Answered: 40 Skipped: 0



ANSWER CHOICES	RESPONSES	
Extremely familiar	2.50%	1
Very familiar	20.00%	8
Somewhat familiar	32.50%	13
Not so familiar	32.50%	13
Not at all familiar	12.50%	5
TOTAL		40

If you want to bring some changes in the traditional education system, which of the followings do you prefer?

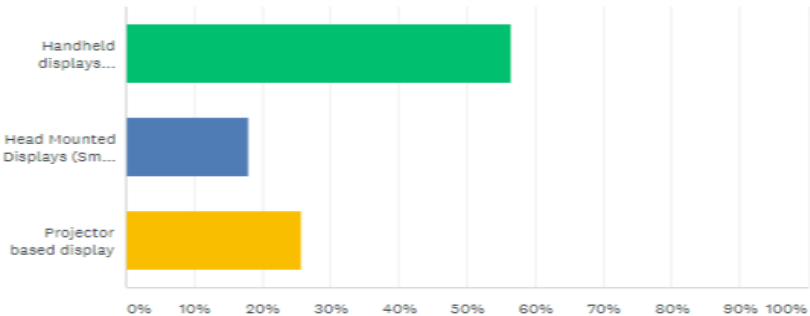
Answered: 40 Skipped: 0



ANSWER CHOICES	RESPONSES	
Provide more information with a Wikipedia link, if possible	30.00%	12
Provide a link of YouTube Video	62.50%	25
Provide references from other books	17.50%	7
Provide reference from social media, if possible	12.50%	5
If you have other suggestions, please specify.	Responses 5.00%	2
Total Respondents: 40		

Which of the following device will be suitable if you want to have a 3D visual experience?

Answered: 39 Skipped: 1

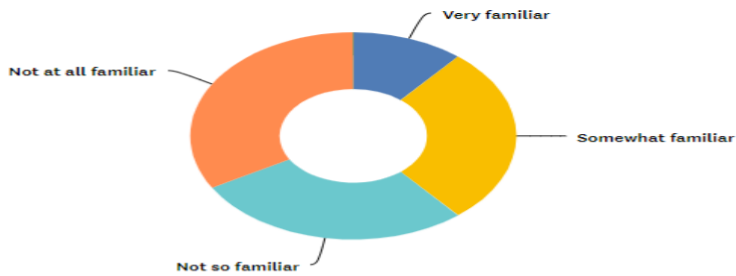


ANSWER CHOICES	RESPONSES	
Handheld displays (Smartphones, Tablet)	56.41%	22
Head Mounted Displays (Smart Glass)	17.95%	7
Projector based display	25.64%	10
TOTAL		39

Questionnaires for Parents:

How familiar are you with the concept of Augmented Reality?

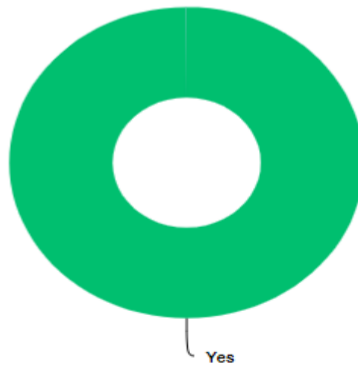
Answered: 18 Skipped: 0



ANSWER CHOICES	RESPONSES	
Extremely familiar	0.00%	0
Very familiar	11.11%	2
Somewhat familiar	27.78%	5
Not so familiar	27.78%	5
Not at all familiar	33.33%	6
TOTAL		18

Do you have smartphones at your home (accessible to your child)?

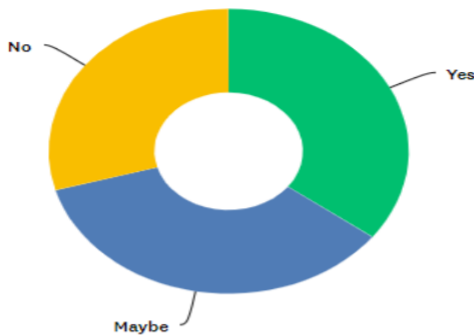
Answered: 17 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	100.00%	17
No	0.00%	0
TOTAL		17

Can you afford 3D supported devices?

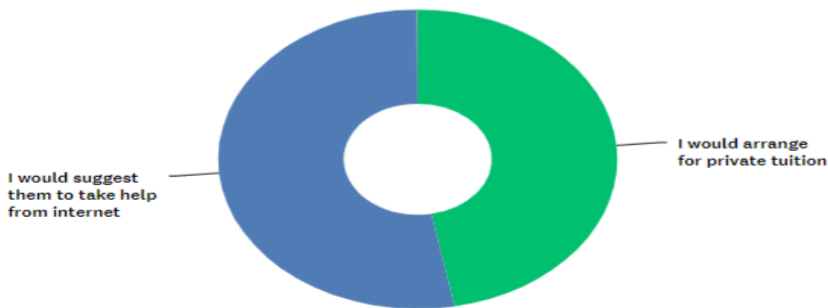
Answered: 17 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	35.29%	6
Maybe	35.29%	6
No	29.41%	5
TOTAL		17

Select your preference (In case your child faces problem while studying)

Answered: 17 Skipped: 1



ANSWER CHOICES	RESPONSES	
I would arrange for private tuition	47.06%	8
I would suggest them to take help from internet	52.94%	9
I would do nothing.	0.00%	0
If you have other preferences please specify.	Responses 0.00%	0
TOTAL		17

How long are you comfortable to allow your child to be on internet other than school activities?

Answered: 17 Skipped: 1



ANSWER CHOICES	RESPONSES	
5-6hours	64.71%	11
6-7 hours	0.00%	0
7-8 hours	5.88%	1
As long as they want	29.41%	5
TOTAL		17