Clicker System Optimization

MTP Stage-2 Report

Submitted in partial fulfillment of the requirements for the degree of
Master of Technology

Under guidance of
Prof. Deepak B. Phatak

Submitted By
Anoop Dobhal
Roll No: 123050062

Department of Computer Science and Engineering
Indian Institute of Technology Bombay
Mumbai
Acknowledgement

I would like to thank my guide, Prof. Deepak B. Phatak, for his consistent directions and guidance throughout the project. His perpetual motivation, patience and excellent expertise in discussion progress of the project work have benefited me to an extent, which is beyond commendation. Because of his consistent encouragement and right directions, we are able to do this project work efficiently and correctly. I would also like to thank Mr. Nagesh Karmali for his continuous support throughout project work. Special thanks to my colleagues and friends for providing me useful comments, suggestions and continuous encouragement.
Abstract

Now a days, clickers are called with many names like CRS(Classroom Response System), ARS(Audience Response System), SRS(Student Response System) and many more. Many questions are still in the queue, which are yet to be answered, like, Do clickers improve learning, What type of questions will enhance students participation and improve their knowledge?

This report presents an overview of clickers system, methodologies accepted for improving active participation of students, from the start of hardware clickers to software clickers implementation in portable devices like tablets, mobiles, PDA, or laptops. This report also presents kinds of problems and their connection to active learning in various modes of quizzes, questions types, devices and technologies used. Lastly, in this report, we presents an recommendation system for improving learning in classrooms.
## Contents

1 Introduction  
   1.1 What is Clicker  
   1.2 Uniqueness of clicker  
   1.3 Types of data collected  
   1.4 Downside of clickers  
   1.5 What Classroom Response System(CRS) can add to a learning environment  

2 Literature Review  
   2.1 Advantage of Clickers  
   2.2 Observations  

3 Clicker development at Indian Institute of Technology Bombay (IITB)  
   3.1 CLICKER 2009A, Ver 1  
   3.2 Clickers in distance education for a multiple classroom environment  
      3.2.1 Approach  
      3.2.2 Architecture of the Distributed Student Response System  
   3.3 Web Based Clicker System for Akash Tablet  
      3.3.1 Different modules in AkashClicker  
      3.3.2 General Constraints or Limitations in AkashClicker  

4 Problem Formulation  
   4.1 Motivation  
   4.2 Problem Statement  
   4.3 Scope of the Project  
   4.4 Constraints of the Project  

1
4.5 Assumptions and Dependencies ........................................ 20
4.6 Proposed System ......................................................... 20
4.7 Algorithm for Recommendation System ......................... 21
  4.7.1 Algorithm for modifying the Parameters ..................... 21
  4.7.2 Scenarios for User Ui ............................................. 21
  4.7.3 Scenarios for User Qj ............................................. 22
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Hardware Clicker developed at IITB</td>
<td>12</td>
</tr>
<tr>
<td>3.2</td>
<td>Distributed System Setup</td>
<td>13</td>
</tr>
<tr>
<td>3.3</td>
<td>Flow Diagram</td>
<td>14</td>
</tr>
<tr>
<td>3.4</td>
<td>Protocol Diagram</td>
<td>15</td>
</tr>
<tr>
<td>3.5</td>
<td>Software Clicker developed at IITB</td>
<td>17</td>
</tr>
<tr>
<td>4.1</td>
<td>sequence of correctness</td>
<td>23</td>
</tr>
</tbody>
</table>
Chapter 1

Introduction

Clickers, known with many names like ARS (Audience Response System), CRS (Classroom Response System), SRS (Student Response System), PRS (Personal Response System), etc. which act as learning aid for better understanding of course material and individual growth. There are a lot of educational softwares in market for e-learning environment. Clicker system are one of the e-learning software, which act as reading and writing tool that help students to achieve growth and knowledge. In early years, before invention of smartphones, clickers are just act as an hardware tool based on InfraRed communication. The cost and other installation overheads led to next generation of clickers. Now a days smartphones, tablets, or laptops with internet access are used as clickers. Generally student do not ask their doubts in class due to fear or a class is so big that not all get chance to communicate with teacher, because of this major concern, clickers came into an existence.

As we gaze out at the sea of slouching bodies and expressionless faces, it is hard to resist wondering if students want less education and more entertainment. Rand W. Guthrie and Anna Carlin

1.1 What is Clicker

Clickers are act as medium of communication between teacher and students. It use infrared or radio frequency technology for transmitting and receiving data. Clickers as previously explained, can be an any portable handheld device like smartphones, tablet, laptops or any hardware are given to all
students in the class. The teacher can ask question or post quizzes during
class, student then give response through their device. The overall feedback
is tabulated and displayed on the projector.

1.2 Uniqueness of clicker

The main theme which make clicker different from other teaching pedagogy
is that teacher always have a right track of lecture going on. As student
responses are collected in teacher computer, so teacher can correspond to
responses according to priority or usefulness of responses during class.

1.3 Types of data collected

In order to better understand methodologies in use, the data collected is rep-
resented as interview, survey, questionnaire, quizzes, test results, observation,
field notes, etc..

The most frequently data collection form is surveying and quizzes specially
multiple choice quizzes. The response to this collected data can be individual
or group. Sometime individual response is followed by group discussion.

1.4 Downside of clickers

- If iclickers are used in a class, then cost factor comes between learning.
  Which includes installation cost, maintainance cost, etc..

- As clickers generation is in rapid growth, now portable devices like
  smartphones, tablet, laptops are replacing addional cost factor and in-
  stallation cost, as mostly students carry mobile portable device. But
  still some student are unable to arrange these devices. This portable
  devices have some ill-effects on students. Student can reflect to other
  sides of portables device use if wifi connectivity is available all the time.

- Now a days active learning participation is implemented by using SMS
  services also. Student send their responses through SMS to teacher
  device with the help of sms-gateway. This approach has cost factor of
  sms-pack. Sending sms is not free, so sometime students avoid giving
  their responses.
1.5 What Classroom Response System (CRS) can add to a learning environment

There are lot of pedagogical and implementation methodologies are proposed. Many of them change the form of teaching. Studies have a proof of increased student participation and active involvement. But the question in time is that, what CRS can add to a learning environment?

- On what basis of comparison it should be rectify, either by difference in the use, or lack of use, of a CRS?

- What type of pedagogical approache required to provide greater understanding, group-based, individual, individual response followed by group-discussion.

- What types of question formats will help student in greater extent?

- How to adjust the pace of presentation and explanation strategies according to student feedbacks?
Chapter 2

Literature Review

There are a lot of changes happened in pedagogical construct, such as the timing of feedback, affordances and limitations of traditional CRS, moving from current generation to next generation of CRS. In this chapter we give a brief survey or research related to clickers. Most of the literature survey lights on Pedagogical Theory and Implementation.

Roy P. Pargas (2006) [14] describes a Web based tool: MessageGrid, which is a two-dimensional grid like structure for posting queries. Any one can post or reply to queries. Later they added feature of clicker for conducting quizzes and questionnaire. It also supports ink-based animated software for writing hand written response or queries. Roy P. Pargas et al. (2006) also presented an approach to teach algorithm and data structure course by using a web-based tool called by MessageGrid.

Scott Teel et al. (2012) [17] also presented a web-based student response system using existing user portable devices, a wireless network and a cloud-based backend server and a database. So eliminating additional cost of hardware and installation overhead. It also supports text and image for questions. Instructor use google doc for adding questions and later invoking web-based php script for adding question from google doc to MySql database.

Abderrahmane Lakas et al. (2006) [9] implemented a tool, ACP an interactive classroom response system for active or cooperative learning environment. It supports some protocols which allows the students to discover the current server IP address and allows the server to push the assessment results.

Eusebio Scornavacca et al. (2007) describe a TXT-2-LRN, sms-based classroom interaction between students and instructor. Instructor mobile is connected to laptop to receive sms responses through SMS gateway, or SMS
David Lindquist et al. (2007) [10], Wolfgang Hrst et al. (2007) [6], Craig Prince (2007) [15] describe the use of mobile devices in active participation during classes. It reduces the cost and installation overhead for setting CRS. Similarly, L. Jackowska-Strumillo et al. (2013) [7] describe a concept of using clickers software in portable devices like tablet, laptops, PDA or mobile phones.

Joana Cruz e Costa et al. (2008) describe a browser based CRS, where student application was implemented using J2ME and instructor application implemented as dynamic web page.

Monika Andergassen et al. (2013) [1] presented similar approach, a browser-based mobile clicker, which is a platform independent tools operated via any internet-enabled device. It also support spatially distributed communication. The system was developed over package called XoWiki content flow available in XoWiki framework. The main key of this approach is that, at different state we can present different content to different kinds of users.

Matthias Hauswirth et al. (2009) [4] implemented software clickers in java, that support richer problem types other than only multiple choice. Their system was a Java based Classroom Response System for Teaching Java, in which problem is defined as Syntax, Types, Coding and Control Flow. They represent the Solve and Evaluate Approach in which students who solved their problem can evaluate problems of other students.

Beth Simon et al. (2010) [16] also implemented java teaching software in active classroom.

Simmilar work is done by Daniel Zingaro et al. (2013) [19] they implemented Python Classroom Response System (PCRS), that can be used by instructor in classroom to run both PI (multiple choice) and code-writing questions. The P CRS is entirely web-based tool so it can used using laptops and tablets. The code submitted by students is executed on a server which returns feedback on student machine.

T. Mantoro et al. (2010) [12] describe Survynvote a web-based tool for audience response system. Another web-based tool was presented by M. Jagar et al. (2012) [8] named as Auress, the audience response system. Similarly later, M. Llamas-Nistal et al. (2012) [11] present web-based Audience Response System using the educational platform called BeA, a web form use by students as a device, which can be operated by any portable device like tablet, mobile and laptops.

Brian T. Davis (2010) [3] describes a method used in CRS for numerically
intensive courses. This method involve decomposition of numerical problem into steps, which can utilize CRS. Then use of CRS in identifying the appropriate equation for a problem. Finally generation of numerical problem responses.

M. Miura et al.(2012) [13] describe a Device-Free Personal Response System based on Fiducial Markres. It involves collecting student responses by means of printed fiducial markers. Tracking technology based on computer vision, students hold their marker sheet and camera catch their responses. The interaction techniques: Response for Multiple Choice Questions and Response by Pointing (using elevation and heading angle) are the key-point in their research. This system have some major drawbacks occlusions and insufficient lightning. High camera resolution which is needed to increase the overhead on instructor system and also decrease the image tracking refresh rate.

A similar approach was presented by Andrew Cross et al.(2012) [2] using a laptop and an off-the-shelf webcam, their software automatically recognise students responses.

Reinicke B et al.(2012) [5] implemented an CRS application called uRespond on ipad. The purpose of their research was to develop a free form student input such as graphics, calculation, drawing, or structure creation and manipulation.

Palmo Thinley (2013) [18] discuss about the use of tablet in teaching and learning environment.

Robert Law (2013) presents an ongoing project based on quick response (QR) codes and google forms for generating rapid response polls and quizzes. The process followed by installing google app on user mobile phone. The key components of this system are QR codes, Google spreadsheet, bar code reader, Google form and Google Scripts. This system have no cost overhead.

### 2.1 Advantage of Clickers

- Clickers technology and advancement Provide instructors, a new way of teaching and improving methodologies of learning.

- Students participation increased, as students start involving in class by giving feedbacks, asking questions, giving responses in form of quizzes, exams.

- As students response collected and tabulated during the class itself, so
instructor get a good hand on students understanding about a subject.

2.2 Observations

The following observations made through detail literature survey of research related to clickers, ARS (Audience Response System), CRS (Classroom Response System), SRS (Student Response System), or PRS (Personal Response System).

- Type of response, either group or individual, or both affects active learning, depend upon the understanding of course material.

- Inspite of a list of advancement risen in clickers, results are still not highly adequates.

- Pedagogical Theory (affordances and limitations in traditional CRS) or Implementation Studies (where and how data are collected, types of data collected in order to better understand methodologies in use) affects the type of learning.

- Various questionaire submitted by students shows their interest towards CRS, but their responses are still not very promising.

- Selection of question type play an important role in clicker system.
Chapter 3

Clicker development at Indian Institute of Technology Bombay (IITB)

Clicker development at Indian Institute of Technology Bombay (IITB) is a Ministry of Human Resource Development (MHRD) project aimed to improve active learning by motivating students active participation in or outside class. Generally, It is used for collecting attendance, creating and conducting quizzes, generating reports, polling and feedbacks in real time.

3.1 CLICKER 2009A, Ver 1

In 2009 the first clicker system which was developed at IITB based on handheld device. It was combination of two device, one at student side for sending response and other one at instructor side for collecting students response. The receiver and clicker both are designed on a Texas Instruments, CC2510-F32 Low-Power SoC (System-on-Chip). The receiver has the same design as a clicker with some additional circuitry of level converter MAX-232. The clicker is normally in sleep mode. When you have to give response, you press a certain key ST (start) only then the clicker wakes up and comes in to operational mode. The response keyed in is stored in the clickers memory and the receiver collects the responses of all the clicker by polling them in a sequence. A computer connected to the receiver collects responses using a small program and sends the results to the IIT-B central server. The ad-
vantage of clicker and receiver based on the same design is that they are interchangeable, so if a receiver fails to work, any clicker can be converted in to receiver by connecting to an additional small circuitry. Figure 3.1 shows the model of hardware clicker used in IITB. The receiver at

![Figure 3.1: Hardware Clicker developed at IITB](image)

instructor side is powered through any computers USB port. The receiver, through easy-to-use software, logs and stores the data of each individual student. The instructor can then display voting results in a graph, to the students. The results are also available for later analysis, grading, and exporting to any grade book software or course management system. The main drawback of this system is cost overhead around 600 for first version and around 1100 for next version. To overcome this, android based clicker system developed at IITB.
3.2 Clickers in distance education for a multiple classroom environment

To provide use of clicker in distance education, Divya Tiwari et al. (2010), IITB, describe a synchronous, distributed approach for use of student response system.

![Distributed System Setup](image)

**Figure 3.2: Distributed System Setup**

3.2.1 Approach

The main idea of clicker system use in distance learning lies in the use of xml file, which contain response of students from different participating remote centres. The central server initiate the response collection at all participating remote centres. The data collected is then transferred back to central server using FTP.
3.2.2 Architecture of the Distributed Student Response System

The key feature of Distributed Student Response System is that, it is developed using open source software and a handheld device. The hardware part is consist of multiple radio frequency based clickers. The lectures were broadcast through EDUSAT, a satellite dedicated to education sector by the Indian Space Research Organisation. Figure 3.2 shows the architecture of different remote server connected to central server. Figure 3.3 shows the flow diagram of how communication carried out between central and remote server.

![Flow Diagram](image)

Figure 3.3: Flow Diagram

The software side of this system is divided into two parts:

- For displaying question to be asked during active lecture. This part is initiated by the central server. The software at each remote centre is managed by respective coordinator at each centre.

- Read, store and interpret the data collected from different participating remote centres. The responses, which are written in xml formats are
transferred to main server using FTP. This part is runs at each of the remote centre.

Figure 3.4 shows the protocol of collecting responses from different remote server.

### 3.3 Web Based Clicker System for Akash Tablet

The main purpose of web based clicker system is to provide a suitable and easy communication between student and instructor. It can be accessed from
the main centre or from any remote centre with ease. Earlier, desktop based version of clicker was dependent on specific hardware and software to run on some specific system. But, AkashClicker provide a web based interface for active learning regardless of type operating system.

3.3.1 Different modules in AkashClicker

- **Admin**: It provide facilities to admin for adding, editing, fetching and deleting the information. Also control access permissions like student login and instructor login.

- **Raise Hand**: This is new facility added in AkashClicker, which provide the facility to ask questions or doubt regarding course. The instructor can reply to doubt by checking the list of student, who pressed raised hand button.

- **Polling**: Used to conduct questionnaire.

- **Question Bank**: Provide the facility of adding and searching a questions for conducting exams or quizzes.

- **Create Quiz**: This module provide the facility of creating quiz by fetching questions from Question Bank.

3.3.2 General Constraints or Limitations in AkashClicker

- Works best in latest version of Mozilla Firefox and Google Chrome.

- Lack in vocabulary of scientific symbols.

- Used for real time response.

- Limited to HTTP/HTTPS.

- It requires an Internet browser to fetch Clicker Web Application through url on AakashClicker and at the remote centers.

---

1Figure 3.2, 3.3, 3.4 are cited from Divya Tiwari el al.(2010), IITB, Figue 3.1 is cited from user manual of CLICKER 2009A, Ver 1, IITB, Figue 3.5 is cited from Summer Internship Project 2012 at IITB

16
Figure 3.5: Software Clicker developed at IITB
Chapter 4

Problem Formulation

4.1 Motivation

Inspite of a lot of applications developed over the years for increasing and improving active participation of students. Clickers with many names like SRS, ARS, PRS, CRS or voting system are in the race of improving teaching methodology. From start of true/false or multiple choice questions responses to graphics, calculation, drawing, or hand-written questions responses. To reduce the installation cost, overhead and device cost, a lot of changes circumnavigated. Reinicke B et al.(2012) [5], T. Mantoro et al. (2010) [12], David Lindquist et al. (2007) [10], Wolfgang Hrst et al. (2007) [6], Craig Prince (2007) [15], and others give the idea of implementing mobile, tablet or laptop based clickers, thus reducing the cost factors.

M. Miura et al.(2012) [13], Andrew Cross et al.(2012) [2] presents the use of fiducial markers using the technology based on computer vision. The TXT-2-LRN approach presented by Eusebio Scornavacca et al. (2007) was able to reduce unwanted overhead greatly.

Being of all these innovations and theories, still there is something missing. Different results shown by different researchers has not given rise to full participation by students. It is assumed that Unlike hardware clickers, software clickers, implemented in mobile, tablet or other portable devices give some form of distraction to students. Due to this distraction results are not upto the mark of pure participation like in case of SMS-based learning students can easily distract from learning mind. Also, it is assumed that if same questions are posted to all students, then their is a chance that students will cheat
in order to show excellence. These small perceptions and general assumptions are the prime source of motivation in this study.

4.2 Problem Statement

In a large or even small classroom, there are different kind of students. They have different scale of learning depend upon there nature and past experience. So dividing students into category of learning power is difficult task for a instructor. There were lots of up and downs were implemented and optimised for improving learning in effective manner but still best response yet not accrued. Still students are not able to understand the problems.

One solution to the problem is to use Recommendation System, as recommendation system is implemented in varities of social world sites, there is convergent focus of applying recommendation system in learning through use of clickers in classrooms.

4.3 Scope of the Project

- To provide better learning environment in classroom.
- To provide means to change current clicker system learning environment beyonds only tabulating students responses and displaying results.
- To provide users to give responses according to their intelligence level.
- To provide system to change questions difficulty level according to users response.

4.4 Constraints of the Project

- To adjust the pace of presentation and explanation strategies according to student feedbacks.
- Bandwidth management problem as numbers of user increases.
- Maintaining each student data can create extra load on server.
• What types of question formats will help student in greater extent?

4.5 Assumptions and Dependencies

• The Smartphone or tablet on which the clicker application runs, should support WiFi.

• The user should have a stable internet connection with a minimum bandwidth of 128kbps to view and give responses.

4.6 Proposed System

How can recommendation system can be applied:

• First same kind of question will be given to all students.

• Then students responses and some kind of feedback is collected at instructor side.

• Based on data collected at instructor side, our recommendation system will give easy or tough question.

• Those students, who solved the early problem, we will recommend tough question to them and those students, who were not able to solve the early question will by recommended by easy question.

• Our system is based on Rasch model (is a psychometric model for analyzing categorical data, such as answers to questions on a reading assessment or questionnaire responses, as a function of the trade-off between:-

  – The respondent’s abilities, attitudes or personality traits
  – The item difficulty. For example, they may be used to estimate a student’s reading ability

• Maintaining two variables Qi and Ui, Qi is question difficulty value for each Qk question and Ui is user intelligence value for each user Ui. the values of this variables will be change according to user responses.
4.7 Algorithm for Recommendation System

Qi is difficulty score for question Qk
where

\[ 1 \leq k \leq n \quad (4.1) \]

n is total number of questions

Ui Every user in the system assigned with a number Ui, this parameter is user intelligence, more the number, he/she is more capable of solving problems. Value of this parameter varies between 0 and 1.

Initial Values
A new user or new question is assigned with unbiased 0.5 values. Based on the questions taken the parameters are expected to go UP or DOWN.

4.7.1 Algorithm for modifying the Parameters

Pi = Probability that user will answer the question correctly, as a function of (Ui and Qj)

if( Ui taken Qj )

\[ P_i = e^{U_i - Q_j} / 1 + e^{U_i - Q_j} \quad (4.2) \]

if( correct )

\[ U_i = U_i + (1 - U_i) * (1 - P_i) \quad (4.3) \]

\[ Q_j = Q_j - Q_j * P_i \quad (4.4) \]

else

\[ U_i = U_i - U_i * P_i \quad (4.5) \]

\[ Q_j = Q_j + (1 - Q_j) * (1 - P_i) \quad (4.6) \]

4.7.2 Scenarios for User Ui

1. if the user is highly expected to answer correctly (pi is larger, so 1-pi is smaller), then he/she answers correctly. no surprise, add little intelligence to his bucket
Ui+ (1-Ui) * (1-Pi)

2. if the users is not expected to answer correctly (pi is smaller, so 1-pi is larger), then he answers correctly, it is a surprise, add intelligence parameter is tuned much

Ui + (1-Ui) * (1-Pi)

3. if the users is highly expected to answer correctly (pi is larger, so 1-pi is smaller), then he answers wrongly, it is surprise, penalize intelligence parameter

Ui - (Ui) * (Pi)

4. if the users is not expected to answer correctly (pi is smaller, so 1-pi is larger), then he answers wrongly, no surprise, penalize little

Ui - (Ui) * (Pi)

4.7.3 Scenarios for User Qj

1. if the users is highly expected to answer correctly (pi is larger, so 1-pi is smaller), then he/she answers correctly. no surprise, add little intelligence to his bucket

Qj = Qj - Qj*Pi

2. if the users is not expected to answer correctly (pi is smaller, so 1-pi is larger), then he answers correctly, it is a surprise, add intelligence parameter is tuned much

Qj = Qj - Qj*Pi

3. if the users is highly expected to answer correctly (pi is larger, so 1-pi is smaller), then he answers wrongly, it is surprise, penalize intelligence parameter

Qj = Qj + (1-Qj)*(1-Pi)
4. if the users is not expected to answer correctly (pi is smaller, so 1-pi is larger), then he answers wrongly, no surprise, penalize little

\[ Q_j = Q_j + (1-Q_j)*(1-P_i) \]

According to responses of user Ui(user intelleigence) score will change for that particular user. Same in case of Qj(question difficluty score) will change as responses from user collected. Score of Qj and Ui normalised in equations so that value will not fall outside. Figure 4.1 shows the tree representation of scenerios discussed for Qj and Ui.

\[ 0 < value \leq 1 \]  \hspace{1cm} (4.7)

Figure 4.1: sequence of correctness

Figure 4.1 gives insight into scenarios explained in section 4.7.2 and 4.7.3, where all the four cases represented as tree structure.
Chapter 5

Test Results
Chapter 6

Conclusion and Future Work
Bibliography


