Clicker System Optimization

M.Tech. Project Stage-1 Report

Submitted in partial fulfillment of the requirements for the degree of

Master of Technology in

Computer Science and Engineering

Submitted by

Anoop Dobhal
Roll No. 123050062

Under the Guidance of

Prof. Deepak B. Phatak

Department of Computer Science and Engineering

Indian Institute of Technology Bombay
Powai, Mumbai, India 400076
October 2013
Acknowledgment

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

Nowadays, clickers are called by 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?, etc. This report presents an overview of clickers system, methodologies accepted for improving active participation of students, from the start of hardware clicker’s to software clicker’s 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, it presents a Problem Statement and Proposed Solution for solving today’s clickers pedagogical and implementation issues.
## Contents

1 Introduction .................................................. 3  
   1.1 What is Clicker ....................................... 3  
   1.2 Uniqueness of Clicker ................................ 4  
   1.3 Types of Data Collected ............................... 4  
   1.4 Downside of Clickers .................................. 4  
   1.5 What Classroom Response System (CRS) can Add to a Learning Environment ........................................ 5  

2 Literature Review ........................................... 6  
   2.1 Advantage of Clickers .................................. 9  
   2.2 Observations ............................................. 9  

3 Clicker Development at Indian Institute of Technology Bombay (IITB) ........................................ 10  
   3.1 CLICKER 2009A, Ver 1 .................................. 10  
   3.2 Clickers in distance education for a multiple classroom environment .................................. 12  
      3.2.1 Approach ........................................... 12  
      3.2.2 Architecture of the Distributed Student Response System ........................................ 13  
   3.3 Web Based Clicker System for Aakash Tablet ........... 15  
      3.3.1 Different modules in AakashClicker ............... 15  
      3.3.2 General Constraints or Limitations in AakashClicker ........................................ 15  

4 Problem Formulation ......................................... 18  
   4.1 Motivation ............................................... 18  
   4.2 Problem Statement and Proposal ........................ 18  

5 Conclusion and Future Work .................................. 22
List of Figures

3.1 Hardware Clicker developed at IITB .......................... 11
3.2 Distributed System Setup ........................................... 12
3.3 Flow Diagram ......................................................... 13
3.4 Protocol Diagram ..................................................... 14
3.5 Software Clicker developed at IITB .............................. 17

4.1 Pedagogical Scripts ..................................................... 19
4.2 Item Management (left), Survey Management (middle) and Test Item Answering (right) Work-flows ................. 20
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., act as learning aid for better understanding of course material and individual growth. There is a lot of educational software in market for e-learning environment. Clicker system is 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 smart-phones, clickers 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 smart-phones, tablets, or laptops with internet access are used as clickers. Generally students 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. Due to 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 act as medium of communication between teachers and students. It uses infrared or radio frequency technology for transmitting and receiving data. Clickers as previously explained, can be any portable hand-held devices like smart-phones, tablet, laptops or any hardware given to all students.
in the class. A teacher can ask question or post quizzes during the lecture. Students can then give response through their device. The overall result is tabulated with different statistics and displayed on the projector.

1.2 Uniqueness of Clicker

The main theme which makes clicker different from other teaching pedagogy is, that teacher always has a right track of the on-going lecture. As students’ responses are collected at the teachers side, so he/she can correspond to the responses, according to priority or usefulness of responses during class.

1.3 Types of Data Collected

In order to understand methodologies in use, the data collected is represented 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 hardware clickers are used in a class, then cost factor comes between learning, which includes installation cost, maintenance cost, etc..

- As clickers generation is in rapid growth, now portable devices like smart-phones, tablet, and laptops are replacing additional cost factor and installation cost, as mostly students carry mobile portable device. But still some students are unable to arrange these devices. These portable devices have some ill-effects on students. Students can reflect to other sides of portable devices, if WiFi connectivity is available always.

- Now a day’s active learning participation is implemented by using SMS services also. Student send their responses through SMS to the teacher device with the help of SMS-gateway. This approach has cost factor
of SMS-pack. Sending SMS is not free, so sometimes students avoid giving their responses.

1.5 What Classroom Response System (CRS) can Add to a Learning Environment

Many pedagogical and implementation methodologies are proposed. Most of them change the form of teaching. Studies have a proof of increased student participation and active involvement. The question arises that, what CRS can add to a learning environment?

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

- What type of pedagogical approach is 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 the responses of student?
Chapter 2

Literature Review

Lot of changes have taken place in pedagogical construct, such as the timing of feedback, affordances and limitations of traditional CRS, moving from current generation to next generation of CRS, etc. 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) describes a Web based tool: MessageGrid, which is a two-dimensional grid like structure for posting queries. Anyone 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 MessageGrid.

Scott Teel et al. (2012) also presented a web-based student response system using existing user portable devices, a wireless network, a cloud-based back-end server, and a database. Thus 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) 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’s mobile is connected to a laptop to receive SMS responses through SMS gateway, or SMS studio (SMS Management System). David Lindquist et al. (2007) [10], Wolfgang Hrst et al. (2007) [6], and 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’s application was implemented using J2ME and instructor’s application was implemented as dynamic web page. Monika Andergassen et al. (2013) [11] presented similar approach. A browser-based mobile clicker, which is a platform independent tool operated via any internet-enabled device. It also support spatially distributed communication. The system was developed over a package called XoWiki content flow available in XoWiki framework. The main key of this approach is that, at different states 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. Similar work is done by Daniel Zingaro et al. (2013) [19]. They implemented Python Classroom Response System (PCRS), that can be used by instructor in a classroom to run both PI (multiple choice) and code-writing questions. The PCRS 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 students machine.

T. Mantoro et al. (2010) [12] describe Survnvote, 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] presented 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 involves decomposition of numerical problem into steps, which can utilize CRS and then use CRS for 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 Markers res. It involves collecting student responses by means of printed fiducial markers. Students hold their marker sheet and camera catch their responses by tracking technology based on computer vision. The interaction techniques: Response for Multiple Choice Questions and Response by Pointing (using elevation and heading angle) are the keypoint in their research. This system has some major drawbacks occlusions and insufficient lightning. High camera resolution is needed to increase the overhead on instructor system and 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 web-cam. Their software automatically recognizes students responses.

Reinicke B et al. (2012) [5] implemented a 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] discusses the use of tablets 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 was 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 has no cost overhead.
2.1 Advantage of Clickers

- Clicker technology and advancement provides instructors, a new way of teaching and improving methodologies of learning.

- Student’s participation increases, as students start setting involved in class by providing feedback, asking questions, giving responses in form of quizzes, exams, etc..

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

2.2 Observations

The following observations are made through detail literature survey of research related to clickers, i.e 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, depending upon the understanding of course material.

- In-spite of a list of advancement risen in clickers, results are still not highly adequate.

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

- Selection of question type plays 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 feedback in real time.

3.1 CLICKER 2009A, Ver 1

In 2009 the first clicker system was developed at IITB, which was based on hand-held device. It was a combination of two devices, one at student side for sending response, and other one at the instructor’s side for collecting student’s 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 into operational mode. The response keyed in is stored in the clickers memory and the receiver collects the responses of all the clickers 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 advantage of clicker and receiver based on the same design is, that they are interchangeables, so if a receiver fails to work, any clicker can be converted into a 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 was 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, describes 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 contains response of students from different participating remote centers. The central server initiates the response collection at all participating remote centers. 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 hand-held device. The hardware part is consisting of multiple radio frequency based clickers. The lectures were broadcast through EDUSAT, a satellite dedicated to education sector by the Indian Space Research Organization. Figure 3.2 shows the architecture of different remote server connected to central server. Figure 3.3 shows the flow diagram of how communication is carried out between central and remote server.

![Flow Diagram](image)

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 center is managed by respective coordinator at each center.

- Read, store, and interpret the data collected from different participating remote centers. The responses, which are written in XML formats
Figure 3.4: Protocol Diagram

are transferred to the main server using FTP. This part is executed at all remote centers.

Figure 3.4 shows the protocol of collecting responses from different remote server.
3.3 Web Based Clicker System for Aakash 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 center or from any remote center with ease. Earlier, desktop based version of clicker was dependent on specific hardware and software to run on some specific system. But, AakashClicker provides a web based interface for active learning, regardless of the type operating system.

3.3.1 Different modules in AakashClicker

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

- **Raise Hand:** This facility has been added in AkashClicker, which provides the facility to ask questions or doubt regarding course. The instructor can reply to the 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 questions for conducting exams or quizzes.

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

3.3.2 General Constraints or Limitations in AakashClicker

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

- Lacks 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.

\footnote{Figure 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}
Figure 3.5: Software Clicker developed at IITB
Chapter 4

Problem Formulation

4.1 Motivation

The motivation behind the clicker system development was risen by the advancement in teaching methodologies. The main focus of clicker system is to provide an effective interface, so that active participation by students in class can be increased. The motivation for the project is to provide an interface for communication between students and instructor more efficiently, and also to provide multiple form of questions which include images, data-flow diagrams as part of programming lectures. As instructor asks same questions during quizzes or exams for all students in large class, there is a chance that student can cheat during exams for getting good grades. So, can we provide an interface, which can generate different content to different students? Also during quizzes or exams, some student solve the problem early, some do not, so the time between early response and late response can be utilized in different context, like, students who solved the quiz early can evaluate the response of other students. The other source of motivation is a limitation of clicker, when number of students are more, then connection failure problem occur due to unavailability of bandwidth. This problem can be solved by using load balancing over multiple access points.

4.2 Problem Statement and Proposal

The following problems rely on the general study through detailed literature survey of research related to clickers, ARS (Audience Response System),
CRS (Classroom Response System), SRS (Student Response System), or PRS (Personal Response System) and also on clicker system at IITB.

- How can we solve the problem of time gap utilization, when one student solve quiz early and other students do not?
  The problem of waiting time for students, who solved questions early during quiz can be utilized. This waiting time can be utilized by providing an approach called Solve and Evaluate given in [4]. In this approach student, who solved question early can evaluate answers of other students. In this way, students will get a better hand on a problems, and can improve their learning.

![Figure 4.1: Pedagogical Scripts](image)

The Figure 4.1 shows the context of the students who have completed the quiz and are waiting for others to finish. But blue bars in lower figure of Figure 4.1 shows students evaluating other students responses after giving their responses. Thereafter, that instructor and students discuss problems and then the instructor reveals the answers.

- How can we add functionality of generating different content to different kind of students?
The idea presented of providing different content to different kinds of users is suggested by developing clicker application over XoWiki content flow (Neumann, 2008) package extension of XoWiki framework (Content Management System). Using state transitions, content flow package manage different state of content object via set of transition. Based on this content flow, different kinds of work-flows, like, filling in questionnaires with multiple forms, providing various kinds of individual feedback and conducting online exercises, quizzes or exams can be defined. Using browser-based interface and portable devices like mobiles or tablets, we can define such system. Figure 4.2 shows the graphs (state transitions) of three types of work-flows namely Item Management (create, publish and unpublished test
questions), Survey Management (create, publish and unpublished surveys) and Test Item Answering (collect answers from the survey participants).

- When only single access point is used, then managing WiFi connection is big hurdle. When multiple access point are used, then problem of load balancing is a big hurdle. How can we solve the problem of connection failure in large class, when all students start logging-in at the same time?

Generally load balancing algorithms are defined over hardware or software. Round-robin DNS is a load balancing technique, where multiple IP addresses are associated with a single domain name; clients can choose server accordingly.

There are variety of scheduling algorithms are there used by load balancer for finding server. Factors, which affect selection of appropriate server, are, server’s reported load, recent response times, up/down status, number of active connections, geographic location, capabilities, or traffic.

\[1\]

---

\[1\] Figure 4.2: Item Management (left), Survey Management (middle) and Test Item Answering (right) Work-flows cited from [1], Figure 4.1: Pedagogical Scripts cited from [4]
Chapter 5

Conclusion and Future Work

The overall study circumnavigate around the use of clicker effectively. We discussed clicker implementation in different context like pedagogical and implementation issues. We discussed about, how clickers are used in portable devices like smart-phones, tablets, mobiles, or PDA, which reduced the cost overhead, was major drawback of hardware clickers. Our solution is based on three main factors:

- Utilizing the time gap can improve student learning.
- By presenting different content to different kind of students can sure that students will not be able to cheat during exams or quizzes.
- It is possible to block the other sites or deny access to the server while students writing their responses.
- It is possible to provide better load balancing algorithm for managing multiple access points in large class.

In future:

- We can provide an interface for asking and producing programming language questions in class, like syntax, or coding.
- Tutorials can be integrated into the application, where in the student can browse through the subject whenever required.
- We can provide recommendation system for enhancing learning capabilities of learner. We can add learning exercises in class based on
recommendation system, i.e., if some student solve question efficiently then we can provide some tough questions to those students, and if, some student face difficulty in solving them, we can then provide easy questions to them.
References


