



# Development of Target-Group Specific Innovative Android-Based Mathematics Educational Modules

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## ABSTRACT

Innovative teaching methodologies are the needs of the hour in Indian Educational Scenarios. Different methodologies which assist the process of learning are also required as a non-conventional medium of imparting knowledge. With advent in time, the growth of technology and related automation has proved to be a viable tool for this purpose. Moreover, inclination of the target-set, that is, the students towards the various technologies available also proves to be helpful in the concept. With phenomenal growth in mobile phone communication technology, the versatile android based applications have become widely popular in various fields of day-to-day activities. In this paper, a series of android based applications in form of games, which impart learning of mathematical concepts of simple arithmetic, sequences and series, game theory and group theory are presented. In every application developed, the various concepts are simulated using interactive games combined with various rewards for the user. The developed application series currently targets students of primary, secondary and undergraduate levels.

Keywords: Education, android, e-learning, application, technology, simulation

## INTRODUCTION

Conventional teaching methodologies even though are time tested; carries various drawbacks with them. Increasing the supply of inputs such as infrastructure or teachers in India's primary education system can ensure 'schooling for all' but not 'learning for all' [1]. Annual Status of Education report [2] states the diminishing quality of education delivered and the knowledge acquired by students at the primary level. Access to education and further delivery of quality education remain an important challenge in both urban and rural contexts. Basic addition and subtraction skills are lacking in different

sectors of students. On the other hand, an early grasp on these topics is essential. Furthermore, the understanding and realizing the practical essence of what a student learns is also a key factor. Despite the implementation RTE act [3] in 2002, 'learning by doing' essentially remains absent in various spheres of education. Shortage of teachers is also a major drawback at majority of educational institutions which inhibit imparting of quality education. Problems with school education in India [4] states that "The key divide between knowledge & learning is the ability to think and apply. Innovation in education then hinges on "to do new", to encourage "thinking" among young learners." A typical Indian school focuses on the completion of formal education by conventional 'blackboard' methodology and doesn't take in account the need of different ways to help 'slow-learners' cope up with the education being delivered. India's poor performance in the Programme for International Student Assessment (PISA) tests (India ranked 71 out of 73 nations) is a serious concern on the methods employed for teaching in India.

The advancement in communication technology offers a viable solution to transform educational pedagogy from school levels. Upcoming technology based devices like computers and mobile phones have a huge potential of transforming the ways of learning in the field of education. A natural adaptation and ever increasing interest of newer generation of students in these modern devices can be used advantageously to invent newer methods and to overcome various drawbacks in teaching practices. Teaching and learning mathematics in Primary School [5] shows that students had problems in areas which are understood conventionally as difficult areas in mathematics such as place value, arithmetic operations with larger numbers, fractions, measurement and geometry. However, there are several critical areas of concern even in the learning of lower level concepts. These areas require innovative methodologies to explain the related principle, concepts and most importantly their applications. The proper utilization of mobile phone technology can provide a good support to the education system in teaching mathematical concepts. Learning via 'interactive' and 'indulging' methodologies can provide an alternate for teaching of certain concepts. Android mobile operating system is such one platform which is used to impart education in a new manner. In this paper, we are presenting a series of android based applications in form of games, which impart learning of mathematical concepts of simple arithmetic, sequences and series, game theory and permutation groups. The developed application series currently targets students of primary, secondary and undergraduate levels. In every application developed, the various concepts are simulated using interactive games combined with various rewards for the user.

## METHODOLOGY

In developing interesting and innovative android based mathematical games for students following methodology was adopted. First an appropriate area of mathematics to impart knowledge is identified based on interaction with school students at different level. Four areas of mathematics targeting various learner groups in present study are (i) Simple arithmetic for primary class students (ii) Sequences and series for secondary class students (iii) Game Theory for secondary and undergraduate class students and (iv) Group theory for undergraduate class students.

The selection of subject area is followed by concept masking in the form of android application based games. The conceptualization of a concept in game form is most interesting and challenging task. The next step is to make related module with the help of android application. It involves devising efficient methods of expression of knowledge/tricks behind the concepts. Last step is to convert the module/ game into a ready to use or ready to install format.

These applications combine ‘learning’ with ‘fun’. It makes knowledge accessible, indulging and attractive to the target segment. Innovative methods of demonstrating/teaching a concept are employed. Applications form a baseline for various kinds of studies and analysis. The core objective of the applications is to impart the knowledge of Mathematics to students at various levels, viz , schools / undergraduate by the means of fun android applications. This is achieved by development of Complete Packages of android apps to create a new innovative paradigm of imparting education via modules in form of interactive games/apps.

## RESULTS

The table-I given below shows the mathematical concepts covered in the present android based game series and the respective Target-Groups of students.

Table - I : Target-Group based classification of android based game series

<b>Mathematical concept</b>	<b>Target –Group of students</b>
<b>Simple Arithmetic</b>	Primary class
<b>Sequences and Series</b>	Secondary class
<b>Game Theory</b>	Secondary/Undergraduate
<b>Group Theory</b>	Undergraduate

The details of the concepts and the implementation are as follows

### **(A) Android Application 1: Simple Arithmetic (Arithmetic Operations)**

The application developed put forwards the concepts of basic arithmetic in an interactive game based manner targeted for Primary Students. The application presents a student with various levels sorted according to the difficulty. Simple time based questions are presented in an attractive interface with a given time. A student needs to answer those questions to collect points. These points can be accumulated and used to unlock their favorite characters such as mickey mouse, tom, jerry etc. The application thereby with its different and innovative methodology of teaching catches the attention of a student and he ‘learns while playing’.

### **(B) Android Application 2: Sequences and Series(Patterns)**

Sequences and Series are based on observational and analytic skills of a student. The type of series along with its stability is important parameters in this respect. This application provides for an educational experience for the young learners who are exposed to sequences and series in a manner that is much departed from the conventional. The users

are presented with some initial terms of the sequence for an understanding of the pattern of the sequence after which the challenge would be to identify the wrong term in the series presented. The challenge is not merely limited to this; the application takes it to another level where the time of identification of this term is also taken into consideration. The earlier one identifies it, the greater would be the reward. The points awarded reduce with the increase in the time of identification. This way the user remains engaged all throughout thereby increasing the learning outcome of the exercise undertaken. The application developed put forwards the concepts of Sequences and Series in an interactive game based manner targeted for secondary class students. Figure-1 shows four snap shots of android based game of sequence and series (Patterns)

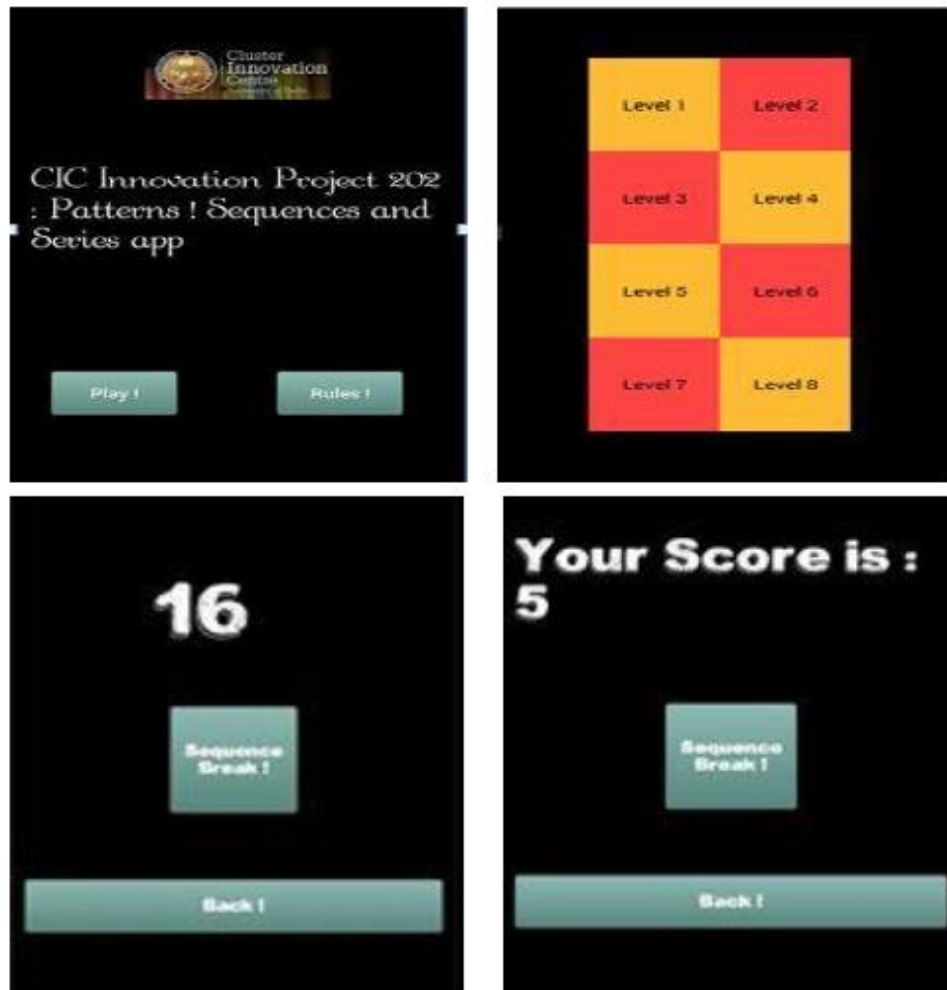


Figure 1 : Sequences and Series (Patterns) Andorid Application

The developed game of sequence and series (Patterns) involve eight levels of series. The mathematical concept involved of each series is as mentioned in Table-II.

**Table - II : Concepts involved in Sequence and Series android apps**

<b>Series Level</b>	<b>Mathematical Concept</b>
<b>Level 1</b>	Simple Arithmetic Tables (of Lower Multiples)
<b>Level 2</b>	Simple Arithmetic Tables (of Higher Multiples)
<b>Level 3</b>	Multiplicative and Additive Series Combined (of Lower Orders)
<b>Level 4</b>	Multiplicative and Additive Series Combined (of Higher Orders)
<b>Level 5</b>	Geometric Progressions
<b>Level 6</b>	Progressions (Increasing differences)
<b>Level 7</b>	Fibonacci Series
<b>Level 8</b>	Recursive Series

**(C) Android Application 3: Game Theory (Optimal strategies)**

Game Theory is a field which has wide applications ranging from simple games like ‘chess’, ‘cards’ etc. to critical military scenarios. The introduction of Optimal Strategies is also important as an optimal strategy ensures good pay-off’s in different situations. The developed application named “Optimal strategies” is a game based explanation of important concepts of the Game Theory. The game involves players entering numbers lying in the range 1 to 10 with the sum increasing with each declaration. The number that makes a whole of 100 would be the winning entry. The game includes variations of the concept with sound mathematical explanation for a detailed understanding of the optimal strategies involved in the field of Game Theory. This facilitates an understanding of dynamics of many other games. In game theory, an optimal strategy is something which maximizes one’s yield or output considering that the opponent is playing with his best possible strategy. In some cases, it is possible to find such a strategy which leads one player to win for sure. In this game in order to win for player A, it is necessary for him to make sure that the opponent may at most reach to 99 i.e. he has to reach 89 and similarly to 78, 67, 56, ..., 12. So, if player B starts with 1, and then ensures that the total sum is of the form  $11n+1$  for some natural  $n$ . He is sure to win. It is also worth noting that any player who once reaches this strategy first and then sticks to it will win for sure. We use this in our easier version where one gets some chance to reach the optimal strategy. Hints are also provided for assistance based learning. If a player doesn’t win he has the option to view the concept behind the game and hence get the solution. The application developed puts forwards the concepts of game theory in an interactive game based manner targeted for

secondary class and undergraduate students. Figure-2 shows three snap shots of android based game of game theory (Optimal strategies).

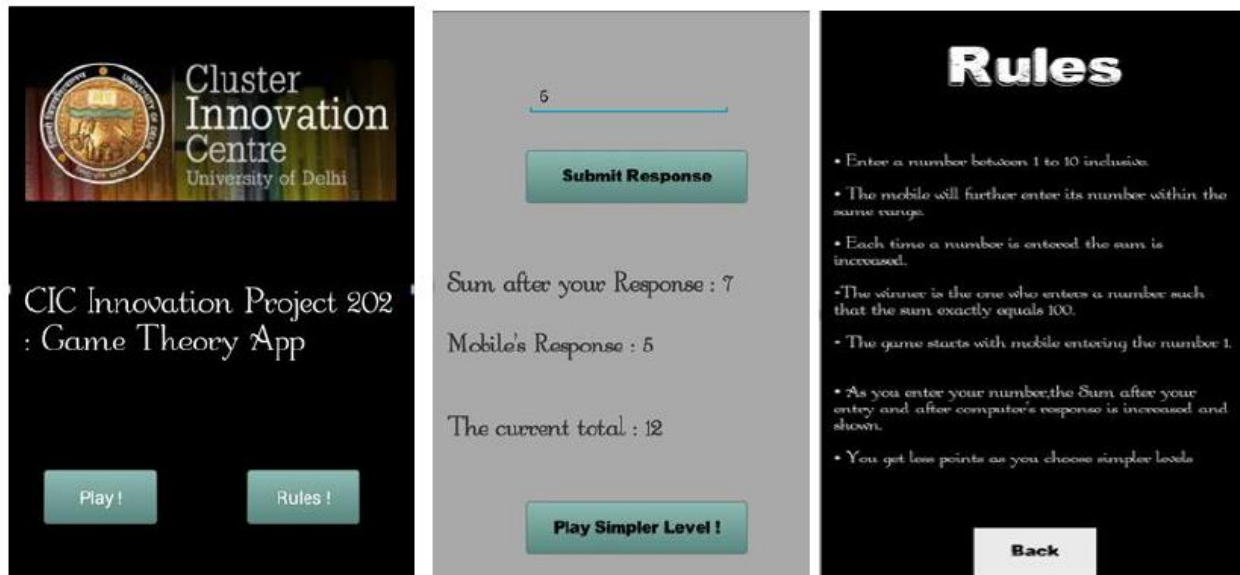


Figure 2 : Game Theory (Optimal Strategies) Android application

#### (D) Android Application 4: Group Theory (Permutation Groups)

This game is based upon some simple group theory especially permutation groups. Group is like any other set but with an operation defined upon it under which set should be closed and an element called identity of the group and inverse to each element. For example, let's suppose we a set  $S$  having three elements  $(1,2,3)$ . Now, if we consider the set of all permutations of  $S$ , it had a total  $3!=6$  permutations. We can list all six permutations as following and any combination of these permutations can be represented again by some single permutation from the list.

- $(1,2,3) \rightarrow (1,2,3)$  denoted as  $(1)$
- $(1,2,3) \rightarrow (1,3,2)$  denoted as  $(23)$
- $(1,2,3) \rightarrow (2,1,3)$  denoted as  $(12)$
- $(1,2,3) \rightarrow (2,3,1)$  denoted as  $(123)$
- $(1,2,3) \rightarrow (3,1,2)$  denoted as  $(132)$
- $(1,2,3) \rightarrow (3,2,1)$  denoted as  $(13)$

Here, it shall be noted that above representation of any permutation is not unique. This very structure is known as permutation group. In this way, any group can be thought of as some permutation group. In the current version of the game, we have six elements whom we are permuting, but we are not allowing all the possible permutations but only a small subset of set of all possible permutations with 6 elements. This small subset is called a subgroup and it means this small subset is itself a group and it is a portion of some big group already known. If we denote 'RR-C' and 'LR-C' as 'R' and 'L' respectively then 'RR-AC' and 'LR-AC' can be denoted as  $R^{(-1)}$  and  $L^{(-1)}$  respectively. Now look at the final configuration of the game  $(234)$  as a permutation of  $(1,2,3,4,5,6)$ , so whole game

can be translated as the following question:

Denote  $(234)$  as the factors of  $R=(13456)$  and  $L=(123)$ .

With a little computation one can show that  $(234) = (R^{-1})L^{-1}R$ .

With this, one can figure it out that not all permutations can be generated with the given moves.

This android application captures the complex seeming concept of permutations group through a simple permutation of a game. The game starts with a preset arrangement of six numbers in a grid of seven spaces with one space left empty to facilitate movement across the grid. The application then re-arranges these numbers. The intent of the game is to reach the original arrangement through a set of four moves. These moves are as follows:

- a) LR-C : Rotate Left Ring Clockwise
- b) RR-C : Rotate Right Ring Clockwise
- c) LR-AC : Rotate Left Ring Anti-Clockwise
- d) RR-AC : Rotate Right Ring Anti-Clockwise

There are two rings which are color coded. Blue and White Colors  $(2,7,5,6,3)$  denotes the left ring and Red and White Colors  $(1,7,4,2)$  represents the right ring.

The game at present makes sure that these moves are a set of generator function set. This ensures that there exist four moves that would actually help retrieve the original state. The application developed put forwards the concepts of group theory in an interactive game based manner targeted for undergraduate students. Figure-3 shows three snap shots of android based game of permutation groups.

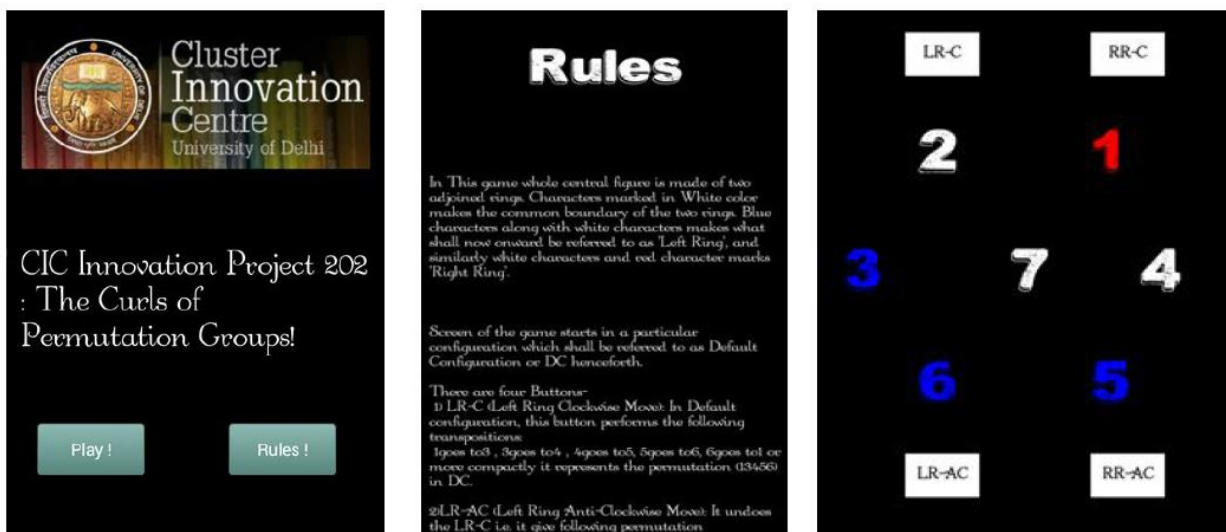


Figure-3 : Group Theory (Permutation Groups) Android application

## DISCUSSION

There are various drawbacks in the conventional methods of teaching. These drawbacks become even more dominant around certain concepts which require a visualization of the concept. The advent of time has led to developments in the technological arena which can assist the solution to these drawbacks. Android is one such platform of technology which is used to impart knowledge about certain concepts in an interactive and indulging manner. The applications built, attract a student and are 'reward-based'. These help solve the problems of accessibility, simulation of important concepts and provide a new teaching methodology. They follow the notion of 'learning with fun'. These also form the baseline for various kinds of studies and analysis as a future prospect which can be important in the fields of psychology, statistics and other research areas.

## CONCLUSION

Android applications (apps) are most sought after solutions for most of the day-to-day problems. These apps are going to play an important role in transforming field of education. The knowledge of Android technology to the undergraduate students has provided a passage to them to express their own way of learning in their own language. This together is assisting in team work and peer learning. Present work, four android based app on simple arithmetic, sequences and series, game theory and group theory developed by the students for the students is a testimonial to the new pedagogy that will rule the world in coming time. The developed applications (games) fulfil the purpose of innovative teaching, tackling difficult concepts and providing a type of learning which attracts a student. The scope of making app modules interactive, simulation-based, concept-visualized, freedom of alteration and modification and making them fun-filled is very motivating. This is a surely an innovative change in making for conventional teaching methodologies. The present work has motivated us enough to develop more app in other fields of education like physics and electronics in near future.

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