

Cartesian Ludo: A Mathematical Game to Explore the Concepts of Coordinates

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Abstract- This study was designed to investigate the effect of mathematical game on students' understanding of Cartesian coordinates and plane. The study also aimed at assessing the role of mathematical games in making learning mathematics more interesting. Thus, both quantitative as well as qualitative research methodologies were applied. This study employed a non-equivalent control group quasi-experimental design. The control group comprised of students from class 5th to class 7th from three Delhi-based secondary schools. The control group was drawn through a stratified random sampling technique (based on two aspects - educational attainments and gender i.e. male and female students). The premise of the study was to find out whether, and to what extent, mathematical games can help in improving the understanding of mathematical concepts of students. Cartesian Ludo, a board-game based on Cartesian plane (with Origin, X-axis and Y-axis) and played with two dice and two to four tokens (resembling the traditional game of Ludo) was created and employed for this study. The pre-test and post-test analysis of the study revealed that the mathematical game approach is superior to the conventional method (such as monologic teaching pedagogy) in facilitating better learning outcomes for students.

Key Words: Mathematical game, Cartesian coordinates, Cartesian plane, Learning outcomes

Introduction

Merriam Webster defines mathematics as the science of numbers and their operations, interrelations, combinations, generalizations, and abstractions and of space configurations and their structure, measurement, transformations and generalizations. However precise, such a definition projects mathematics as a complex subject meant to be pursued by intellectually brighter ones only. But beyond such description, mathematics has been related and understood not only as mere numeracy, but a subject equally relatable to aesthetics and humanity. For instance, Bertrand Russell in his 'The Study of Mathematics' stated that "Mathematics, rightly viewed, possesses not only truth, but supreme beauty – a beauty cold and austere, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show." Renowned mathematician Edward Frenkel in his work 'Love and Math' points that "Mathematics is the source of timeless profound knowledge, which goes to the heart of all matter and unites us across

all cultures, continents, and centuries.” Mathematics, therefore, is not meant only for those with higher grey matter, but for all those who can think, imagine, play and discover.

Renowned American mathematician William Paul Thurston argued that “Mathematics is not about numbers, equations, computations, or algorithms: it is about understanding.” This brings us to the importance of mathematical pedagogy i.e. how the mathematics should be taught so as to make learning more interesting and thereby facilitate better and improved understanding of mathematical concepts.

For one, teaching mathematics in isolated form, away from the real life situations, should be avoided. The merely ‘pen and paper’ approach makes this beautiful subject a boring one. Often this teaching methodology not only makes many students disinterested in the subject, but also instills a mathematics-phobia in many.

One of the ways to make studying mathematics interesting is adopting interactive heuristic approach to learning mathematics. This approach involves engaging students in various learning activities, peer teaching, games and outdoor learning. The pedagogical approach, therefore, must not be constrained to conventional classroom method but must incorporate other ways such as the one suggested in this paper – teaching through game-playing.

Teaching through games is one of the best ways to enhance the cognitive understanding of a mathematical concept among students. This has been corroborated by a recent research study “Effect of Mathematical Game on Students Achievement in Quadratic Expressions” by Abonyi Okechukwu published in *International Journal of Scientific and Engineering Research*, Volume 5, Issue 6, June-2014. The study revealed that mathematical game approach yielded a mean achievement score of 82.1311 with a standard deviation of 14.2729 while the conventional method yielded a mean of 52.7551 and a standard deviation of 21.0916, implying that the mathematical game approach is superior to the conventional approach in enhancing students’ achievement in algebraic expressions.

Objective

The objective behind Cartesian Ludo is to introduce the concept of Cartesian plane to children. NCERT introduces the concept of coordinate geometry in class 8th. The target group for this game therefore is students currently studying in classes 5th, 6th and 7th. However, all interested people who want to learn Cartesian coordinates and plane in a practical manner are welcome to play and learn. This game will enhance the understanding of axes, quadrants and sense of direction and position in a more scientific and mathematical manner.

Method and Procedure

The game named Cartesian Ludo has been created which can be played by two to four students at a time. This game involves each student with his/ her token (choosing colours out of any four – yellow, red, blue or green). Two dice have to be rolled, representing X- and Y- axes. Each die is marked: -3,-2,-1,1,2,3 each on six sides of the die. The player has to move according to the

combination that comes up. For example, if the throw of dice gives -2 and 3, then the player has to move two places to the left (i.e. on -X axis) and simultaneously three places upward (i.e. on +Y axis). All the players start from the origin (0, 0), and the aim is to reach the boundary first. In this process, the players learn not only about Cartesian plane and coordinates, but also get introduced to the idea of quadrants.

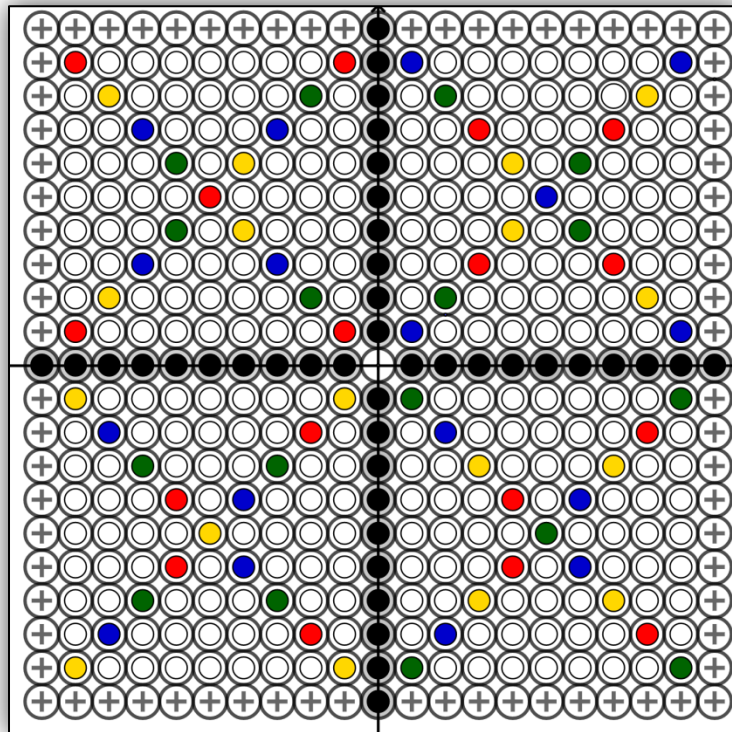








Fig. 1 Cartesian Ludo

Elements

1. Game Board
2. 2 Die
3. Pins

Set Ups

1. Positive numbers imply movement in right and upward directions.
2. Negative numbers imply movement in left and downward directions.

					
Danger zone	Safe zone for red	Safe zone for green	Safe zone for yellow	Safe zone for blue	Target

The students, however, are allowed to have flexible game rules to make the game more interesting for themselves. The larger aim is that students learn the concepts heuristically while enjoying the game-playing. To begin with, the authors of this paper have devised the game in the following two levels:

Level one

1. Blue die is for vertical movement (Y axis) and red die is for horizontal movement (X axis).
2. First player will roll the two dice simultaneously.
3. According to the output he/ she will follow the path to reach the target.
4. A player can be knocked out if he/ she is not on the circle marked by his/ her own color/safe zone.
5. The same cycle will continue in clock-wise direction.
6. The one who reaches the target first will be the winner.

Level two

1. Dice are not fixed for X- and Y- axes. Players have the liberty to choose either die for X- or Y- axis and move accordingly.
2. The player has to reach his/ her own house (last color of safe zone is the corresponding house).
3. First player will roll the two dice simultaneously.
4. According to the output the player will have two options to move. For example, if -3 and 2 comes up, the player can move either 2 in the right and 3 in the downward direction or he/ she can move 2 in the upward direction and 3 in the left.
5. A player can be knocked out if he/ she is not on his/ her own color/safe zone. The player who is knocked out thrice will get disqualified from the game.
6. The same cycle will continue in clock-wise direction.
7. The one who reaches the target first will be the winner.

Results and Discussions

The control group has been selected using stratified random sampling from three Delhi-based schools. The sample size consists of 60 children, 30 male and 30 female students, from each school. They are divided into 3 groups. First group consists of male students only, second group consists of female students only and the third group consists of both male and female students.

Such categorization will be made for each class (standards 5th, 6th and 7th) separately. The motive behind such a categorization is to study the pattern of learning outcomes - both overall as well as between male and female students. The study aims to assess the differential effect of mathematical games on the bases of both – educational attainment and gender-based learning outcomes.

The study involves three stages:

Pre-test - A questionnaire with a set of questions related to direction and position sense is being given to the students and the observations are being noted.

Play game - Playing pattern of the participants is being noted to understand their thinking. Time taken, moves made are being observed for pedagogical research and to study the learning ability of the participants.

Post-test - A post test is being conducted to assess the learning outcomes for participants.

Conclusion and Implications

Multiple iterations of this experiment are being conducted with different sets of students in the sample population. The data thus obtained is being analyzed using mean, standard deviation and analysis of co-variance (ANCOVA). Based on the data analysis, it will be revealed how much change in learning outcome is observed among students and whether mathematical game approach is superior to the conventional teaching approach in facilitating better learning for students.

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