Sports Integration to Develop Understanding related to Physics Concept: A Cross-Curricular Pedagogical Approach

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Abstract- *Using indigenous games as learning tools to understand physics concepts is a good idea that can play a vital role in developing an activity-based physics curriculum. In this study, GulliDanda was used to explain the trajectories of projectiles. This research aims to reveal the effectiveness of this cross-curricular pedagogical approach in cognitive(achievement), affective and psychomotor domain. The quasi-experimental single-group post-test design was adopted to carry out the research. A sample of thirty students belonging to the science discipline from class 11th has been selected for the study. The effectiveness of the indigenous knowledge-based physics path of the projectile object (Gulli) was analyzed. During the playing game, it is demonstrated that the trajectory traced by Gulli is parabolic in nature. It is concluded from the study that Students can engage more readily with indigenous games that help them develop prior knowledge, logical reasoning, concentration, and build their inquiry-based scientific temper epistemologically. This cross-curricular pedagogical approach provides experiential learning to learners in realistic conditions.*

Keywords: GulliDanda, indigenous game, projectile motion, physics

Introduction

Physics originated as the branch of science that attempts to use the language of mathematics to define how nature works. This includes not only the principles that give us some of our most profound notions of space, time, matter, and energy but also the behavior of objects under the action of forces. It also explains why and how real-world events happen and enables us to hypothesize what might happen under certain circumstances. Most of the students consider it a complex subject. The way physics is taught, many times, the concepts of physics and the problems of physics are not clear to students and make the issue difficult for the students. Sometimes Physics tends to discourage the student from studying because of the inherent difficulty of the subject and the dependence on mathematics. Students struggle to understand different aspects such as formulas, calculations, theories, and experiments. Thus, it is essential to use various methods of understanding to make learning physics easy.

As per the National Education Policy 2020, Para 4.8, "Sports-integration is another cross-curricular pedagogical approach that utilizes physical activities including indigenous sports, in pedagogical practices to help in developing skills such as collaboration, self-initiative, self-direction, self-discipline, teamwork, responsibility, citizenship, etc. Sports-integrated learning will be undertaken in classroom transactions to help students adopt fitness as a lifelong attitude and achieve the related life skills and fitness levels as envisaged in the Fit India Movement. The need to integrate sports in education is well recognized as it fosters holistic development by promoting physical and psychological well-being while enhancing cognitive abilities".

The purpose of this study is to measure the effectiveness of using one of the Indian traditional games (Gulli – Danda) as a demonstration tool that helps attract students' attention and enhances their conceptual understanding of the physics concept of the trajectory of projectile motion. Two-way interactions between learners and teachers are the main component of the game-based learning viewpoint, which imparts physics by learning of doing and conceptualization.

Review Related Literature:

Yildirim Z and Baran M (2020) described the influence of physics-based action and online playing on ninth-class learners' attainment during science learning. They examined the effect of playing physics-based activities in a learning environment and the effect of playing digital games in a virtual background on learners' achievement.

Dzjob D. (2020) focused on forming a group board game to examine students' achievement in a physics course. This study indicated the effects of the 'Board game' as an estimation tool to assess elementary-level students' attainment. The study concluded that activity-rooted estimation increases students' conservation of information and gives a chance for enhancement. This also gives collaborative learning experiences. Test anxiety also was reduced through this Game.

Amado C. M. and Roleda L. S. (2019) focused on students' engagement in learning. This study investigates undergraduate students' behaviour and cognitive and emotional engagement in the physics course. The result of this study concluded that students who gain experience in this gamified physics course are students who participate with more attention and more actively. They formed a positive relationship with their classmates and guide. Students experienced feelings of fun and excitement as well as anxiety, stress, and frustration.

Tinedi V et al. (2018) described games as a teaching tool to help learners understand physics-based concepts. This provides a better chance for learners to become independent in the learning process. This study was based on the Indonesian context. This study aimed to increase students' motivation in physics learning through the games. This study showed many techniques to enhance students' enthusiasm to gain knowledge of science concepts while also helping teachers to teach and improve their teaching style and method.

Khouna Jand Ajana L. (2017) discussed the limited use of educational software in a competency-based approach. They talked about the positive contribution of educational games and activities in teaching Physics concepts. They found that the use of educational games as learning and teaching tool is a unique approach to teaching physics based on competencies. It highly provides motivation and fills the gap between learners and learning.

Foster A N and Koehler M J (2016) focused on activities related to the study and efficiency of games to understand physics theory. This study revealed that learners who played the educational game 'Physics' learned physics concepts more effectively.

Price C. B. (2015) focused on some emerging concerns about Physics education which is the reason for the decrease in students' interest in Physics. This study indicated the problems in physics education and gave an innovative clarification that utilized educational activities to educate learners' Physics at the elementary level.

Joshi S. C. (2014) used traditional games as a teaching tool to understand the Physics concept. Classic games help to develop previous knowledge, concentration, and logical reasoning ability. In this study author used brain consistent pedagogical approach. His study showed that with the help of pedagogical activity tools, learners could learn physics concepts in anactive learning environment. By this Gulli Danda game, learners can achieve an average gain in conceptual understanding in school.

Jones J. et al. (2014) studied gamification theories and their application in teaching. In this study, the author focused on a Game-based activity related to physics concepts. According to their research, 'Junkyard Physics' is a physics-based game in which impulse or trust is given to a ball. To play this game, learners need to know about force, impulse, thrust, etc. The correct answer proceeds the game to the next level. This study concluded that gamification is a valuable tool and game mechanic is addictive. This Game can make physics more understandable to male and female school learners.

Joshi S C (2012) developed an activity cum instructional module to educate the learner on science concepts with real-life experiences. According to the author, this study developedlearners' problem-solving skills, scientific attitudes, and inquiry-based temperament. The study revealed that the Game-Based Teaching Model (GBTM) helps in physics learning with enjoyable experiences and increases the popularity of traditional games among the young generation. This develops cultural values among the learners.

The objectivesofthestudy

i. Top repare instructional plans integrating indigenous games, i.e., Gulli Danda.
ii. To assesst he effectiveness of this cross-curricular pedagogical approach sports integration on cognitive (achievement), Affective and psychomotor domains.

Familiarity and Physics Concepts in Gulli Danda:

Gilli Danda/ GulliDanda is a popular traditional game in India and is the national game of Nepal. It is played in rural areas and small towns in India and Pakistan, especially in the Punjab region. Its origin in India dates back to the Maurya dynasty. It is a game for four plus players. In the United States, a similar game is called Pee-wee. It is also known as Tipcat in English, Dandi-Biyo in Nepali, Alak - doulak in Persian and Kon - ko in Khmer (Cambodian language).

For better understanding, we can compare the Danda and Gulli to a bat and a ball. Where Danda is used as a bat to hit the Gulli which serves as a ball. As it is a rural game there are no specific sizes, shapes, or types of materials to be used for the Gulli and Danda. Hence, we can use equipment of any dimension as long as it serves its purpose. The Gulli is a cylindrical wooden piece tapered at both ends. The length is approximately 4 to 5 inches and diameter is around 1 to 1.5 inches in the middle and the ends of it are blunt. A Danda is a straight cylindrical stick of length 15 to 18 inches and diameter of approximately 1.5 to 2 inches. The Gulli, which has conical ends, is initially at rest and the Danda, when raised to a height (h), contains potential energy given as:

$$U_d = m_d g h.$$

Where m_d is the mass of Danda. When a player brings the Danda down to $h = 0$, with velocity (v_d), to hit the Gulli, the potential energy (U_d) in the Danda is transformed into kinetic energy (K_d) (neglecting air friction).

According to the conservation of energy, the potential energy of Danda imparts velocity to the Gulli:

$$U_d = K_d$$

$$Mgh = 1/2\ M\ v_d^{\,2}. \ldots (1)$$

Here the velocity of the Danda is given as:

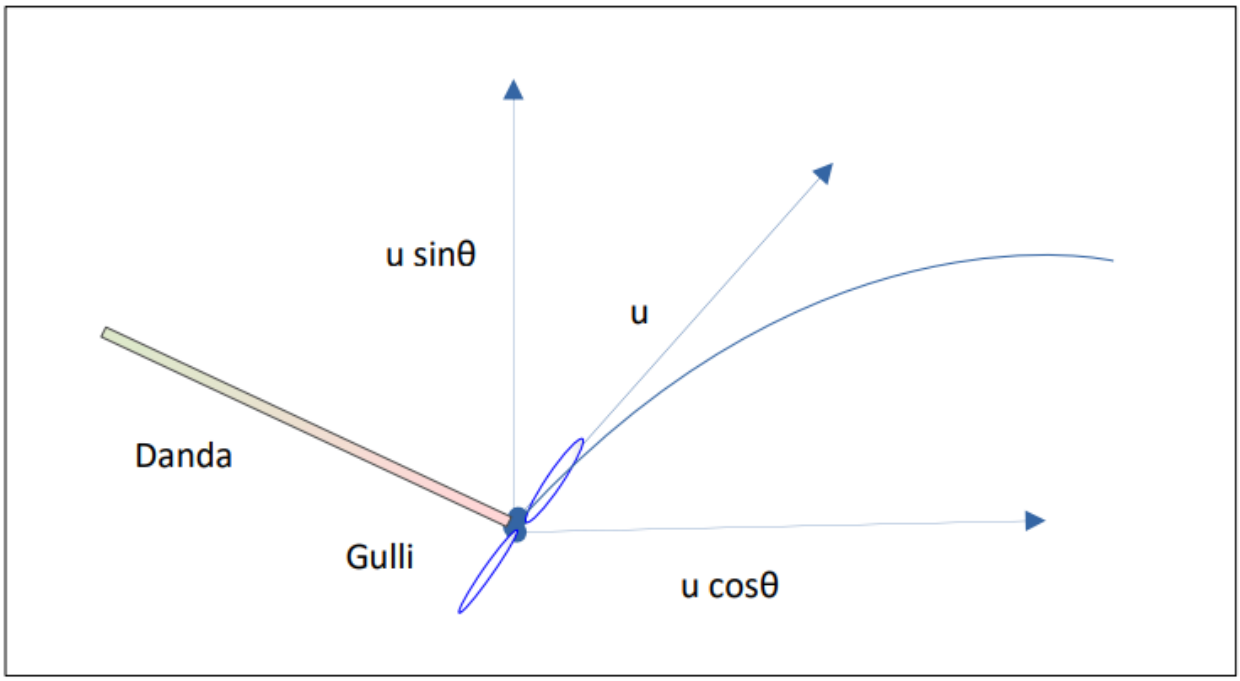
$$the\ v_d = \sqrt{2gh} \quad . \ldots (2)$$

Since there is no net external force in the horizontal direction, the momentum along the horizontal direction will be conserved.

Thus, momentum will be:

$$m_d v_d = m_g u_g cos\theta, \ldots (3)$$

where 'm_g' is the mass and 'u_g' is the velocity of Gulli by which it is projected. The angle 'θ' is made by Gulli with the horizontal axis, known as angle of projection and is shown in figure below.



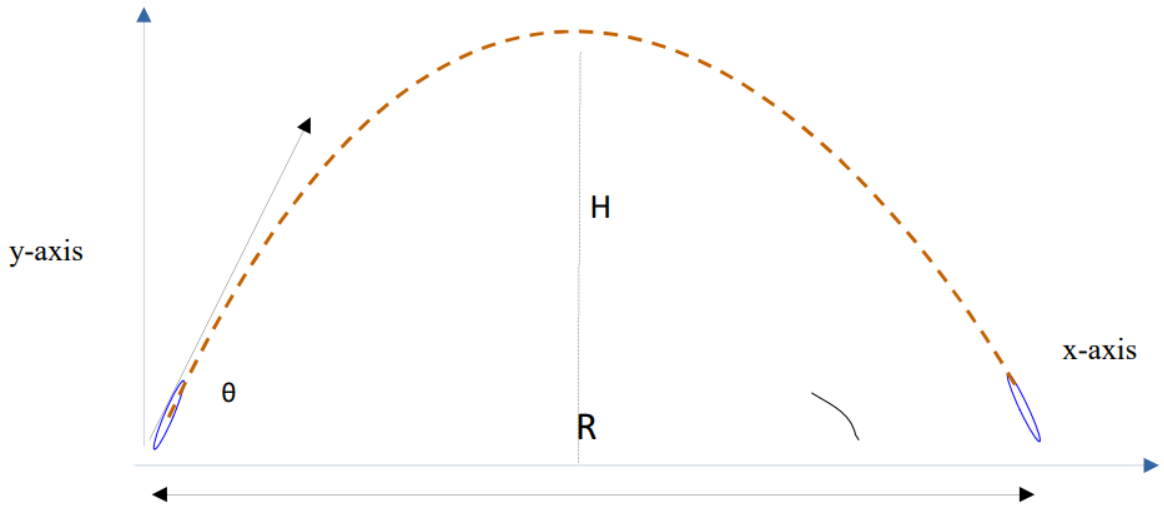
Consider that the player provides an impulse 'I' which makes the Gulli acquires a velocity 'v_g' at a height 'h'. The imparted impulse is given as:

$$I = m_g v_g - m_g u_g = \text{Change in momentum.}$$

Under the gravitational force, the path traced by Gulli is given as:

$$= x\tan\theta - \frac{gx^2}{u_g^2 \cos^2\theta} \ldots (5)$$

where x and y are the distances covered by Gulli with the velocity components in the X and Y axes respectively.



Thus eqn. (5) clearly shows that the trajectory traced by Gulli is parabolic in nature.

Methodology

The study was conducted in three phases:

The first phase of the study:

1. Pre-assessmentrelated to the Gulli Danda game was taken to know how much information they have about the game.
2. Few pre-classes were taken to understand the game's rules.
3. Presentation was given to students aboutthe game for a better understanding: of demonstration tools and their effectiveness in making active classroom learning environments.
4. PowerPoint presentation and Video on "how to play Gulli Danda" were shown to students, and the concept of projectile motion was also explained with the help of the game.
5. After the demonstration, students discussed the complete process.

Second Phase: Implementation

At first, learners will be separated into mini-batches to have enough communication among them.

Now, a demonstration of the game activity was again given in the field by relating to the concept. Good examples were given while demonstrating the game. Discussions will be open at all-time, especially at the time of demonstration for all the learners. Once all queries are resolved, all questions are responded to, and a quick recap of all study components taught in the classroom in terms of main points of concepts.

Sufficient time was given to the students to play the Game so that students could collect their everyday observations and discuss them in their groups.This will help in developing their capacity for their analysisand self-supporting.

Third Phase: Post-test

Post-test was taken to assess the effectiveness of traditional games such as Gulli Danda in learning Physics concepts among students; The quasi-experimental single group post-test design was adopted to carry out research.

Research Method

Method

The research uses the quasi-experimental single-group post-test design.

Variables:

The variables in this research include the independent variable in the form of the GulliDanda game and the dependent variable in the record of achievement.

Population and Sample

Asampleofthirtystudentsbelongingtothesciencedisciplinefromclass11thhasbeen selected for the study. All the students belong to rural areas. Students have been chosen as per the availability in the immediate local area because, at this time, all schools are closed due to the Global pandemic.

Tools:

Gulli Danda was used as a playing tool. An achievement test was prepared. All the questions were based on trajectories of projectile motion. The achievement test had fifteen questions. This includes questions reflecting the students' critical thinking on the given topics. Some questions were related to the explanation of the concepts. Some numerical questions were also included in the post-test. One assessment was also taken to check whether all the students were familiar with the Gulli Danda game or not.

Result:

The response of the students to each question is more explaine din the figure below-

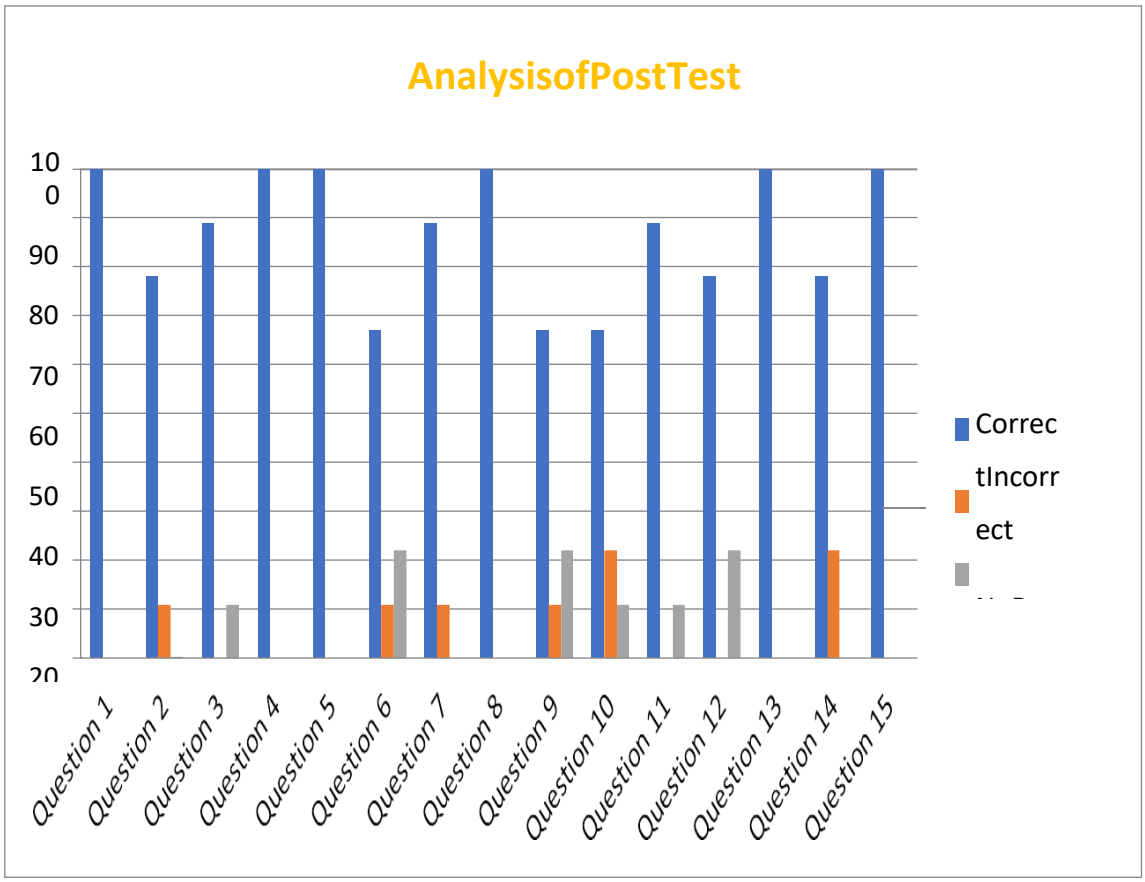


Figure 1: Result of post-test-1

In this figure, the vertical axis represents the percentage of students who have correct /Incorrect/No Responses to the questions, and the horizontal axis represents the question number.

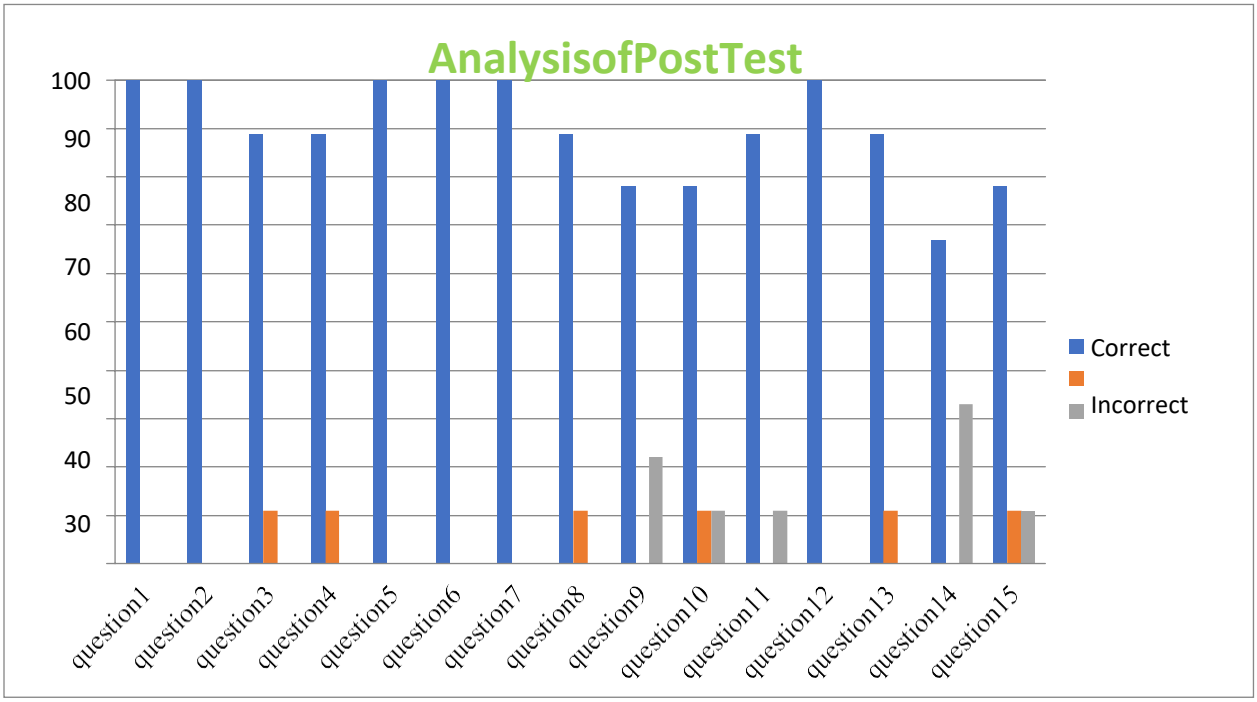


Figure 2: Result of post-test-2

In these figures, the vertical axis represents the percentage of students who have Correct /Incorrect/No Responses to the questions, and the horizontal axis represents the question number.

It was found that two students faced difficulties in understanding the concept of the trajectory of projectile motion. Two students could not understand what questions had been asked. All the students correctly answered questions about the idea of the horizontal range and maximum height. All the students who responded correctly associated with the formula of projectile motion but one of them could not solve the question based on this. Two students made calculation mistakes during solve the numerical problem. It can be said that every learner scored more than fifty per cent (50%) marks on the test.

Results showed how game-based effective teaching could help resolve the learner's difficulties and clarify their concepts with a fundamental understanding.

Conclusion

Many educationists believe schooling is not about learning the facts and concepts to clear the examination. This study provides some conclusions related to curriculum objectives with widely learning. Daily knowledge of students depends on several points such as learners' curiosity in

learning, near atmosphere for learning, tutor's engagement, and positivity to challenges for better understanding. Using Games with teaching in class may be the best method for developing flipped classroom. A review of game-based teaching methods from diverse learners shows that this approach engages the learner in hand work tasks and well-supportive discussion between students, which is the primary thought of flip classrooms. A comfortable environment supports children for reflection. Learners can understand with the help of these demonstration tools.

In this investigation, it is found that students can learn physics concepts more effectively and scientifically. Post-test concludes that almost all students (more than 70%) give the correct answer to the questions.

It is also concluded that teachers can find out the difficulties faced by students and remove them with the help of teaching them realistic principles of Physics discipline using pedagogical activity tools. Post-test results show that no learner scored less than fifty per cent marks. This indicates achieving average gain in fundamental conceptual understanding of learners towards physics concepts through using traditional games.

It also breakdown negative impressions among parents and other stakeholders toward indigenous sports. This cross-curricular pedagogical approach provides experiential learning to learners in realistic conditions.

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