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A Study of the Effectiveness of Digital Pedagogy Programme for Teaching the Laws of Motion to Class XI SSC Board, Maharashtra Students

Pravinkumar Jadhav

Assistant Professor, Ashoka College of Education, Nashik
Email: pravinkumar.jadhav@gmail.com

Abstract:

Physics at the higher secondary level often poses difficulties for learners due to abstract concepts and limited experimental exposure. The present action research study investigates the effectiveness of a digital pedagogy programme integrating simulations, virtual laboratories, animations, and a learning management system (LMS) in teaching the topic Laws of Motion to XI standard SSC Board students in Maharashtra. The study adopted a pre-test–post-test Control group and experimental group research design with a sample of 30 students in each group. Digital instructional strategies were implemented over a period of two weeks. Data were collected using achievement tests, observation schedules, and learner feedback forms. The findings revealed a significant improvement in students' conceptual understanding, problem-solving skills, and learning engagement. The study concludes that digital pedagogy enhances the quality of physics teaching and supports experiential learning in alignment with contemporary educational reforms. Digital pedagogy programme thus holds significant potential for transforming physics education in Maharashtra schools.

Keywords: *Digital Pedagogy programme, Physics, Virtual Laboratories, SSC Board.*

1. Introduction

Physics education at the higher secondary level aims to develop scientific reasoning, conceptual understanding, and analytical skills. However, traditional teaching methods often fail to provide adequate visualization and experimental exposure. With the advancement of educational technology, digital pedagogy programme offers innovative strategies such as simulations, virtual laboratories, and LMS-based assessment to address these challenges. This study explores the effectiveness of a structured digital pedagogy programme implemented in a real classroom setting.

2. Need and Significance of the Study

- ❖ Abstract nature of physics concepts creates learning difficulties.
- ❖ Limited laboratory infrastructure in many SSC schools.
- ❖ Growing emphasis on technology integration under NEP 2020.
- ❖ Need for student-centred and experiential learning approaches.

This research seeks to improve classroom practices and enhance learning outcomes in physics through digital pedagogy.

3. Statement of the Problem

"A study of the effectiveness of digital pedagogy programme in teaching Laws of Motion in Physics to XI standard SSC Board students in Maharashtra."

4. Objectives of the Study

1. To implement a digital pedagogy programme in teaching physics
2. To study its effect on students' academic achievement
3. To analyse its impact on conceptual understanding
4. To examine students' engagement and learning experiences.

5. Hypothesis

Null Hypothesis (H_{01}): There is no significant difference in the mean post-test achievement scores of students taught using digital pedagogy Programme and those taught using traditional teaching methods.

Alternative Hypothesis (H_{11}): There is a significant difference in the mean post-test achievement scores of students taught using digital pedagogy programme and those taught using traditional teaching methods.

6. Methodology Summary

6.1 Research Design

- Design: Quasi-experimental pre-test and post-test control-group design.

6.2 Sample

- Participants: Class XI science stream SSC board syllabus affiliated Junior College students, Experimental Group and Control Group each have 30 students.

6.3 Tools

Instruments: Researcher-developed and piloted Achievement Test (conceptual + numerical), 5-point Likert Student Feedback Questionnaire, observation checklist, LMS usage logs.

6.4 Statistical Tools

- Analysis: paired t-tests for within-group gains,

7. Description of the Digital Pedagogy Programme

The programme was structured to introduce concepts through animations, reinforce understanding using simulations, provide experimental exposure through virtual labs, and assess learning via LMS-based quizzes and assignments.

The programme included:

Sr.No	Digital Pedagogy	Digital Platform	Duration	Week
1	Simulations & Virtual Labs	concept visualization	2 Periods	2 Weeks
2	Animations	explaining dynamic processes	1 Periods	
3	LMS	assessment and feedback	2 Periods	
4	Pre-test and Post-test	Google Form	2 Periods	
5	teacher facilitation.	Teacher training precedes intervention.	1 Periods	

8. Hypothesis Testing and Interpretation of Results

To examine the effectiveness of digital pedagogy programme in teaching the Laws of Motion to XI standard SSC Board students, the collected data were analysed using t-tests at the 0.05 level of significance.

Hypothesis 1

Null Hypothesis (H_{o1}):

There is no significant difference in the mean post-test achievement scores of students taught using digital pedagogy programme and those taught using traditional teaching methods.

Statistical Technique Used

An independent samples t-test was used to compare the post-test mean scores of the experimental group and the control group.

Table 1: Comparison of Post-Test Achievement Scores of Experimental and Control Groups

Sr.NO.	Group	N	Mean	Standard Deviation
1	Experimental Group (Digital Pedagogy Programme)	30	78.40	6.25
2	Control Group (Traditional Method)	30	69.10	7.10

Calculation of t-value- Paired samples t-test.

- Calculated t-value = 4.82
- Degrees of freedom (df) = 58
- Level of significance = 0.05
- Table t-value at 0.05 level (df = 58) = 2.00

Conclusion for Hypothesis 1

There is a significant difference in the achievement scores of students taught using digital pedagogy programme and those taught using traditional teaching methods. Students exposed to digital pedagogy performed significantly better in the Laws of Motion than those taught through conventional classroom teaching.

This indicates that digital pedagogy programme is more effective for teaching Laws of Motion at the XI standard SSC Board level.

Hypothesis 2

Null Hypothesis (H_{02}): There is no significant difference between the pre-test and post-test mean scores of the experimental group.

Table 2 : Comparison of Pre-Test and Post-Test Scores of Experimental Group

Sr. No.	Test	N	Mean	Standard Deviation
1	Pre-Test	30	42.30	5.80
2	Post-Test	30	78.40	6.25

Calculation of t-value- Paired samples t-test.

- Calculated t-value = 18.65
- Degrees of freedom (df) = 29
- Table t-value at 0.05 level = 2.05

Interpretation

The calculated t-value (18.65) is much higher than the table value (2.05). Hence, the null hypothesis (H_{02}) is rejected.

Conclusion for Hypothesis 2

There is a significant improvement in the academic achievement of students after teaching the Laws of Motion using digital pedagogy programme. This confirms the positive impact of digital pedagogy on students' learning outcomes

9. Discussion of Findings

The hypothesis testing clearly indicates that digital pedagogy programme significantly enhances students' understanding and achievement in the Laws of Motion compared to traditional teaching methods at the XI standard SSC Board level in Maharashtra. The findings indicate that digital pedagogy programme significantly enhances students' understanding of physics concepts. Simulations and animations helped visualize abstract ideas, while virtual labs provided experimental learning opportunities. LMS-based assessment ensured continuous feedback and self-paced learning. These results align with constructivist learning theory and previous research in science education.

10. Educational Implications

- ❖ Digital pedagogy programme should be integrated into SSC physics curriculum.

- ❖ Virtual laboratories can supplement physical experiments.
- ❖ Teachers should be trained in digital instructional design.
- ❖ LMS platforms can improve assessment transparency.

11. Limitations of the Study

- ❖ A present study is limited to Small sample size.
- ❖ A present study is limited to Short duration of intervention.
- ❖ A present study is limited to Newton's Laws of Motion physics topic.
- ❖ A present study is limited to SSC Board syllabus and Class XIth Only.

12. Suggestions for Further Research

- ❖ A study of Long-term impact of digital pedagogy programme on student achievement in Physics.
- ❖ Application of Digital Pedagogy programme to other physics topics and classes.

13. Conclusion

The action research study concludes that digital pedagogy programme is an effective approach for teaching physics at the XI standard SSC syllabus. The integration of simulations, virtual laboratories, animations, and LMS promotes conceptual understanding, learner engagement, and academic achievement. Digital pedagogy programme thus holds significant potential for transforming physics education in Maharashtra schools and colleges.

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