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A Study On Difficulty In Solving Problems Of Derivation In Physics Among 9th Standard Students

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ABSTRACT

Physics derivations are a challenging aspect of the 9th-grade curriculum, requiring conceptual understanding, mathematical reasoning and step-by-step problem-solving skills. Many students struggle with derivations due to weak math skills, reliance on memorization and ineffective teaching methods, resulting in low confidence and poor academic performance. This action research employed a one-group pre-test and post-test experimental design with six 9th-grade students to identify difficulties and implement targeted interventions. Three activity-based strategies-"Pathway to Solving Physics Derivation," "Match the Following," and "From Formula to Solution" were implemented. Post-test results indicated significant improvement in students' problem-solving accuracy, logical reasoning, conceptual understanding and confidence. The study highlights the effectiveness of visual aids, activity-based learning and stepwise instruction in enhancing students' derivation skills in physics.

Keywords: Physics derivations, Mathematical Reasoning, Activity-Based Learning, Stepwise Problem-Solving, Visual Aids, Problem-Solving Skills, Confidence in Physics

INTRODUCTION

Physics, a core secondary school subject, helps students understand the principles governing the natural world. However, 9th-grade students often struggle with derivations, which require conceptual clarity, logical reasoning and mathematical skills. Derivations involve a step-by-step reasoning process connecting physical laws to mathematical expressions, not mere memorization. Classroom observations reveal that students face difficulties in understanding derivation steps, applying formulas correctly and linking theory with practical problems. These challenges can lower confidence, academic performance and interest in physics. This action research aims to identify the specific difficulties students encounter in physics derivations and implement targeted strategies to improve comprehension, problem-solving skills and confidence, thereby strengthening their overall foundation in physics.

NEED AND IMPORTANCE OF THE STUDY

Understanding physics derivations is vital for developing students' conceptual clarity, logical reasoning and analytical thinking. Many secondary students struggle with derivations, relying on rote memorization and facing difficulties due to weak mathematical foundations. This often reduces confidence, academic performance and interest in physics. The study aims to identify these challenges and implement student-centered strategies to enhance conceptual understanding, connect theory with practice and make learning physics more engaging, meaningful and confidence-building for students.

STATEMENT OF THE PROBLEM

Physics is a core subject in the 9th-grade curriculum that requires both conceptual understanding and mathematical reasoning. One of the major challenges student's faces is solving derivation problems, which involve logically connecting physical concepts with mathematical formulas. Many students struggle to follow the step-by-step process of derivations, often relying on memorization rather than understanding. This leads to mistakes, low confidence, poor academic performance and reduced interest in physics.

OBJECTIVES OF THE STUDY

1. To identify the difficulties faced by 9th-grade students in solving physics derivations.
2. To analyse the reasons behind students' errors in derivation problems.
3. To strengthen students' mathematical application in physics problems.
4. To develop students' step-by-step problem-solving ability.
5. To increase students' confidence in attempting derivation questions.

CAUSES OF THE PROBLEM

1. **Weak Conceptual Understanding:** Many students lack a clear understanding of basic physics concepts, making it difficult to follow derivation steps logically.
2. **Poor Mathematical Foundation:** Derivations often require algebraic manipulation, knowledge of formulas and arithmetic accuracy. Students with weak math skills struggle to apply these correctly.
3. **Lack of Knowledge of Formulas:** Students often do not know or forget essential physics formulas, which makes deriving related expressions difficult.
4. **Memorization-Based Learning:** Students often memorize formulas without understanding the reasoning behind them, leading to errors in derivation problems.
5. **Lack of Stepwise Reasoning Skills:** Derivations require a sequential approach. Students often skip steps or fail to link one step to another, resulting in incomplete or incorrect solutions.
6. **Limited Visualization Skills:** Physics derivations often involve abstract concepts. Students who cannot visualize relationships between variables and phenomena find it challenging to derive formulas.
7. **Fear and Anxiety:** Difficulty in understanding derivations can lead to fear of physics, reducing motivation and engagement in learning.

8. **Ineffective Teaching Methods:** Traditional lecture-based methods that emphasize rote learning rather than conceptual understanding do not adequately address students' difficulties in derivations.
9. **Insufficient Practice:** Students often do not get enough guided practice or exposure to different types of derivation problems, which limits mastery and confidence.
10. **Lack of Real-Life Connections and Guidance:** Students may not see the practical applications of derivations and without timely feedback and guidance, they may repeat mistakes and fail to understand the correct derivation methods.

PRIORITIZING THE CAUSES

1. Poor Mathematical Foundation
2. Lack of Knowledge of Formulas
3. Memorization-Based Learning
4. Lack of Stepwise Reasoning Skills
5. Ineffective Teaching Methods
6. Insufficient Practice

REVIEW OF RELATED LITERATURE:

Gowda (2023) study titled *"Technology Integration and Visualization in Physics Education"* highlighted how technology, simulations and digital visualizations can make learning derivations more effective. The study found that students who learned through digital tools developed a clearer understanding of the relationship between variables and physical laws. Technology-based instruction also enhanced visualization skills and promoted independent learning.

Sharma (2021), study titled *"Effect of Visual Aids on Students' Achievement in Physics Derivations"* explored how visual aids such as flowcharts, mind maps and illustrated steps influence students' learning outcomes in physics. The findings revealed that visual materials help learners follow the logical flow of derivations and retain formulas better. Students taught with visual methods performed higher in post-tests compared to those taught through traditional lecture methods.

Kumar and Rao (2020), study titled ***"****Enhancing Conceptual Clarity in Physics through Scaffolding Techniques"* explored how scaffolding techniques could help students overcome challenges in multi-step derivations. The research demonstrated that when teachers explained derivations through gradual steps, using supporting diagrams and examples, students developed a stronger conceptual base. This method reduced confusion and improved their problem-solving confidence.

Reddy (2019) study titled *"Understanding Students' Difficulties in Physics Problem Solving"* investigated the difficulties faced by secondary school students in solving derivations in physics. The study revealed that most students depend on rote memorization rather than understanding the logical flow of derivations. As a result, they fail to apply concepts correctly in problem situations. The author suggested that teachers should focus on concept-based teaching and provide simple step-by-step explanations to strengthen student understanding.

RESEARCH METHODOLOGY

The method adopt for this action research is **quantitative research method and employed** experimental research design i.e., one group pre-test and post-test design.

Population: The population for this study is 9^{th} Standard Students of Kannika Cauvery Education Trust, located in Hebbal, Mysore belongs to Hebbal Cluster, Mysore North Block of Mysore District.

Sampling: Purposive sampling technique was adopted with a criteria of- student who were facing problem in solving derivation in physics curriculum who scored less marks in pre-test conducted by the researcher.

Sample Size: The size of the sample is 6 students.

Research Tool: Researcher developed achievement test questionnaire was used to conduct Pre-Test and Post-Test.

PROCEDURE

1. **Pre-Test:** A test was conducted to check the student existing knowledge about solving the derivation physics.
2. **Analyse Pre-Test Results:** The results showed that many students are facing difficulties to solve derivations.
3. **Action Plan:** Planning three activities that helpful to solved the derivation step by step.
4. **Implement the Action Plan:** The activities were carried out within 20 minutes.
5. **Post-Test:** A same test was conducted for the same students to compare the students learning after the intervention.
6. **Result Analysis:** The post-test results showed the improvement in the score and effectiveness of the action plan.

ACTION PLAN

Table -1: Details of Action Plan

Sl. No.	Activities name	Duration	Frequency	Remarks
1.	Pathway to Solving Physics Derivation	20 minutes	2 in a week	Helps understanding effectively
2.	Match the following	15 minutes	1 in a week	Very useful to the students
3.	From Formula to Solution	20 minutes	2 in a week	Gained confidence in solving physics derivation

DESCRIPTION OF ACTION PLAN

Activity 1: Pathway to Solving Physics Derivation:

In order to enable students to understand and apply the step-by-step method to derive the derivations in physics. This activity helped students visualize the step-by-step process of solving derivation problems. Charts that displayed the derivation process, students can easily follow and apply relevant formulas and concepts. The visual representation strengthened their analytical skills and improved retention of key steps.

The positive response and active participation of students showed that visual aids make abstract physics concepts easier to grasp.

Activity 2: Match the following:

Through this engaging matching activity, students were able to connect theoretical terms with their respective formulas or related images. It enhanced their conceptual understanding and recall ability. Students found this activity enjoyable and interactive, which increased their motivation and interest in the topic. The exercise reinforced memory retention and helped in building stronger associations between physics concepts and their mathematical representations. It helps to link derivation problems with real-life applications (e.g., motion, electricity) so that students can relate concepts to everyday experiences.

Activity 3: From Formula to Solutions:

This activity focused on identifying and applying the correct formulas to solve numerical and derivation-based questions. It enabled students to bridge the gap between theory and practical problem-solving. The practice improved their accuracy, logical reasoning and confidence in handling derivation problems. Students developed better clarity in understanding how and when to apply specific formulas. The practice improved their accuracy, logical reasoning and confidence in handling derivation problems.

STATISTICAL ANALYSIS

Statistical analysis of pre-test and post-test scores provides a quantitative assessment of learning outcomes. It not only measures improvement but also guides future teaching strategies by highlighting the areas that need further attention. Overall, it is a reliable method to evaluate the success of educational interventions.

Table-2: Details of samples test scores

Sl. No.	Samples	Pre-Test	Post-Test	T_1-T_2	%
01	Sample 1	10	14	4	20%
02	Sample 2	9	16	7	35%
03	Sample 3	8	13	5	25%
04	Sample 4	7	16	9	45%
05	Sample 5	6	12	6	30%
06	Sample 6	5	15	10	50%

GRAPHICAL REPRESENTATION

This helps to evaluates students' performance derivation problems in physics using pre-test and post-test scores. The results are presented through frequency polygon or line graphs, where the X-axis represents the midpoints of score and the Y-axis represents the frequency of students in each interval.

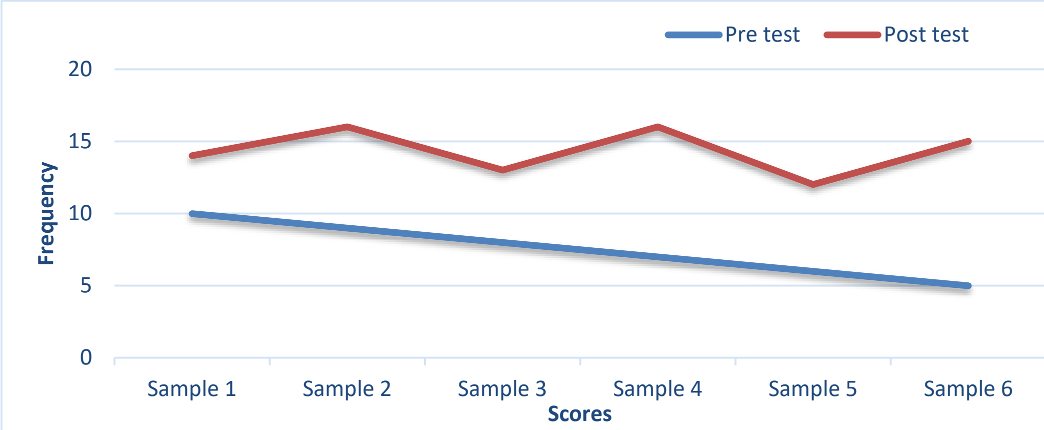

Figure -1: Line graph of Pre-Test and Post-Test Scores

INTERPRETATION OF RESULT

After comparing the pre-test and post-test scored of the said samples, it found that the pre-test score the performance of the student was less and the scores were 10, 9, 8, 7, 6, 5. After the intervention, a post-test was conducted for the same six students. The improvement was indicating positive progress in learning. The scores were samples scored in post-test is 14, 16, 13, 16, 12, 15. The graphical representation clearly shows upward trend from pre-test to post-test, it highlighting progress in students' learning outcomes. Which means that the teaching activities and intervention were effective. Samples performed better after the activities designed in the action plan. It effectively helped students to understand the step-by-step process of derivations and to achieve the highest marks.

RESEARCH FINDINGS

1. The visual representation strengthened their analytical skills and improved retention of key steps.
2. The activity increased their motivation and interest in the topic.
3. It enhanced their conceptual understanding and recall ability.
4. Three targeted activities were conducted to improve their problem-solving ability related to derivations.
5. The practice improved their accuracy, logical reasoning and confidence in handling derivation problems.
6. It helps to relate the concept in their real-life application.
7. Activity based learning make students actively participate in learning context.

SUGGESTIONS

1. **Use visual aids regularly:** Charts, diagrams and step-by-step visuals should be integrated into daily teaching to help students understand abstract Physics derivations more clearly.
2. **Incorporate more activity-based learning:** Conduct similar interactive activities such as "match the formula," "fill the missing step," or "concept mapping" to make learning Physics more engaging.
3. **Use real-life examples:** Link derivation problems with real-life applications (e.g., motion, electricity) so that students can relate concepts to everyday experiences.
4. **Encourage self-study and reflection:** Motivate students to maintain a "Physics derivation notebook" where they write steps and reflect on how each formula is derived.

5. **Adopt differentiated teaching:** Since students have varied learning speeds, additional remedial sessions for slow learners can ensure that everyone achieves mastery.
6. **Integrate digital tools:** Use animations, simulations, or educational apps to demonstrate the logic behind complex derivations interactively.

LIMITATIONS OF THE STUDY

1. The study was restricted to a small sample of six students.
2. Absence of a control group constrained comparative analysis of the intervention's effectiveness.
3. The intervention was implemented over a relatively short duration was confined to a single school.

CONCLUSION

The study concluded that the sample struggle with derive the derivation due to conceptual gaps, lack of activity-based learning, poor in mathematical skill, inadequate practice and insufficient skill, the need for targeted interventions to improve their understanding and application of physics concepts.

Researcher can conclude that the students have shown good improvement in their learning and shows that the teaching method was effective and helped the students gain confidence in solving the derivation problem.

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