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A Study On Difficulty In Selecting Formulas To Solve Numerical Problems In Physics Among High School Students

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Abstract:

This study explores the challenges faced by high school students in selecting and applying correct formulas while solving numerical problems in physics. Many students struggle to connect theoretical concepts with mathematical expressions, resulting in frequent errors, low confidence, and poor academic performance. The research adopted a **quantitative experimental design** using a **one-group pre-test and post-test method** with **seven students** from Kamadhenu Convent, Mysore, who showed difficulty in solving physics numerical problems. Four activity-based strategies- **Chart-based learning, Problem Identification Games, Flashcards, and Match-the-following exercises** were implemented to improve conceptual understanding and formula application skills.

The pre-test average score of **11.14** increased to **18.14** in the post-test, indicating a **35–50% improvement**. The results confirmed that interactive and visual learning approaches significantly enhanced students' understanding, recall, and confidence in problem-solving. Major causes identified included lack of mathematical skills, insufficient practice, and ineffective teaching methods. The study recommends using activity-based, student-centered approaches to strengthen conceptual clarity and promote analytical thinking. Overall, the intervention demonstrated that engaging and well-structured activities can effectively improve students' problem-solving performance in physics and foster a positive attitude toward the subject.

Keywords: Physics Education, Formula Application, Problem-Solving, Activity-Based Learning, Conceptual Understanding.

Introduction

This study examines how students struggle to solve numerical problems in physics. When students solve numerical problems in physics, they often differ in how they choose and apply formulas. Students often struggle to identify relevant formulas or apply them correctly. Students also tend to choose different formulas to solve the same problems, which shows the challenges they face in identifying and applying the appropriate formulas in physics numerical problems. These difficulties may arise from a lack of clarity in the relationship between physical concepts and mathematical expressions. Furthermore, inadequate practice, limited problem-solving strategies, and rote learning habits contribute to their struggles. Therefore, this study aims to explore the challenges students face in selecting and applying appropriate formulas while solving physics numerical problems, with the goal of identifying effective strategies to improve their problem-solving skills.

Need and Importance

1. Many high school students face problems in solving physics numerical questions because they find it hard to choose and apply the correct formulas.
2. Difficulty in solving numerical problems shows that students have a weak understanding of basic physics concepts.
3. Solving numerical problems is very important because it helps students apply theoretical knowledge to real-life situations.
4. This study is needed to identify the exact areas where students face difficulties such as understanding units, formulas, or steps in problem solving.
5. Understanding these problems can help teachers create better teaching strategies and give more practice in solving numerical problems.
6. When students learn to solve numerical problems correctly, they gain confidence and interest in learning physics.
7. This study is important because it helps in improving the overall academic performance of students in physics.
8. The findings can guide curriculum planners to include more interactive methods, examples, and practice exercises in the physics syllabus.
9. Helping students overcome their difficulties in solving numerical problems will prepare them for higher studies in science and technology**.**

Statement of the Problem

Physics is a core subject in the high school curriculum that requires both conceptual understanding and mathematical reasoning. One of the major challenges students face is solving numerical problems in physics, which involve logically connecting physical concepts with mathematical formulas. Many students struggle to follow the step-by-step process of numerical problems in physics, 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 high school students in solving numerical problems in physics.
2. To analyze the reasons behind students' errors in physics numerical problems at the high school level.
3. To develop the ability of step-by-step problem solving among high school students.
4. To increase students' confidence in attempting numerical problems in physics.

Causes of the Problem

1. **Confusion in numerical problems in physics:** Students often get confused identifying what the problem requires, leading to difficulty choosing the right formula.
2. **Lack of mathematical skills and ability:** Weak mathematical foundations make it hard for students to manipulate and apply physics formulas correctly.
3. **Insufficient practice in numerical problems in physics:** Limited practice reduces students' familiarity with formulas and problem-solving techniques.
4. **Ineffective teaching methodology by teachers:** Ineffective teaching methods that lack step-by-step guidance hinder students' understanding of formula application.
5. **Lack of interest:** Low motivation and interest in physics decrease students' effort to learn and apply formulas accurately.
6. **Difficulty in applying formulas in physics numerical problems:** Students struggle to relate formulas to real problem situations and use them correctly.

7. **Students face problems remembering physics formulas:** Memorizing numerous formulas without understanding causes forgetfulness during problem-solving.
8. **Difficulty in understanding the question or problems:** Poor comprehension of problem statements leads to the wrong selection and use of formulas.

Prioritized Causes

1. Lack of mathematical skills and ability.
2. Insufficient practice in numerical problems in physics.
3. Failure in teaching methodology by the teacher.
4. Students face problems remembering physics formulas.
5. Difficulty in understanding the question or problems.

Review of Related Literature:

Tong, T., Pi, F., Zheng, S., et al. (2025). Exploring the effect of mathematics skills on student performance in physics problem-solving: A structural equation modelling analysis. Weak algebraic skills were linked to difficulty in identifying appropriate formulas in physics problems. Students often defaulted to memorized formulas instead of reasoning through the problem conceptually.

Jannah, M., Nasir, M., Siahaan, D. S., & Soewarno, S. (2022). Analysis of students' difficulties in solving physics problems with multiple representation using "What's Another Way" method. Students struggled to select correct formulas when problems were presented in multiple forms. The study emphasized that lack of strategic planning and conceptual understanding increases formula selection errors.

Qotrunnada, N. A. (2022). Analysis of the difficulties of high school students in improving problem solving ability in physics learning. Students demonstrated poor problem-solving skills due to difficulty in choosing the correct formula. Misinterpretation of problem statements was identified as a major factor affecting formula selection.

Park, M. (2020). Students' problem-solving strategies in qualitative physics questions in a simulation-based formative assessment. Students frequently jumped to formulas without first understanding the underlying concepts. The study suggested that scaffolding conceptual reasoning before formula application improves accuracy in numerical solutions.

Mumthas, N. S., & Abdulla, S. U. (2019). Substandard performance in mathematical problem solving in physics among higher secondary school students in Kerala – An investigation on teacher perceptions and student difficulties. The study revealed that students often fail to connect physics concepts with mathematical formulas. Teachers reported that students frequently choose formulas randomly, leading to repeated calculation errors.

Research Methodology

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

Population*:* The population for this study is high school Students of Kamadhenu Convent, located in Hebbal Main Road, near Basavanagudi Circle, Mysore belongs to Hebbal Cluster, Mysore North Block of Mysore District.

Sampling*:* A purposive sampling technique was adopted with the criterion of selecting students who faced difficulties in solving numerical problems in physics and had scored low marks in the pre-test conducted by the researcher.

Sample Size: The size of the sample is 7 students.

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

Procedure

The following procedure was followed in the action research:

1. Identification of the problem.
2. Conducting Pre-test.
3. Identifying samples.
4. Activities development.
5. Implementation of the activities.
6. Post-test.
7. Data analysis.
8. Enlisting research-based findings.
9. Enlisting research-based suggestions.

Action Plan

Table -1: Details of Action Plan

Sl. No.	Activities name	Duration	Frequency	Remarks
1.	Chart based activity	15 minutes	2 in a week	Helps understanding effectively
2.	Problem identification game	10 minutes	1 in a week	Satisfied
3.	Flashcards activity	15 minutes	2 in a week	Gained confidence in solving physics numerical problems
4.	Match the following	10 minutes	1 in a week	Very useful to the students to solve numerical problems

Description of Action Plan

Activity 1: Chart based activity:

A chart-based activity was conducted to help high school students overcome difficulties in selecting formulas for solving physics numerical problems. The chart included various physics formulas arranged visually, allowing students to easily identify the correct formula for a given problem. This method helped students connect concepts with formulas and facilitated effective understanding. The activity also enhanced problem-solving efficiency and proved to be an effective tool for improving students' confidence and accuracy in solving numerical problems.

Activity 2: Problem identification game:

This activity, called Problem Identification Games, was designed to help high school students overcome difficulties in selecting appropriate formulas to solve numerical problems in physics. The game includes a variety of physics formulas and presents them in the context of different numerical problems. Through engaging gameplay, students practice identifying the correct formulas needed to solve each problem. This method not only helps students recognize and recall formulas more effectively but also enhances their conceptual understanding of how and when to apply them in physics problem-solving.

Activity 3: Flashcards activity:

In this activity, students used flashcards containing different kinds of physics formulas. The purpose of the activity was to improve their ability to select the correct formulas and enhance their understanding of numerical problems in physics. By repeatedly practicing with the flashcards, students were able to recognize formulas more quickly, recall them more accurately, and apply them effectively to solve various physics numerical problems. This activity aimed to strengthen both their conceptual understanding and problem-solving skills in physics.

Activity 4: Match the following:

Through this engaging matching activity, students were able to connect theoretical terms with their respective formulas. 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 is very useful for the students.

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	8	18	10	50%
02	Sample 2	12	18	6	30%
03	Sample 3	10	18	8	40%
04	Sample 4	12	18	6	30%
05	Sample 5	12	18	6	30%
06	Sample 6	12	18	6	30%
07	Sample 7	12	19	7	35%

Graphical Representation

This helps to evaluate students' performance in numerical 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.

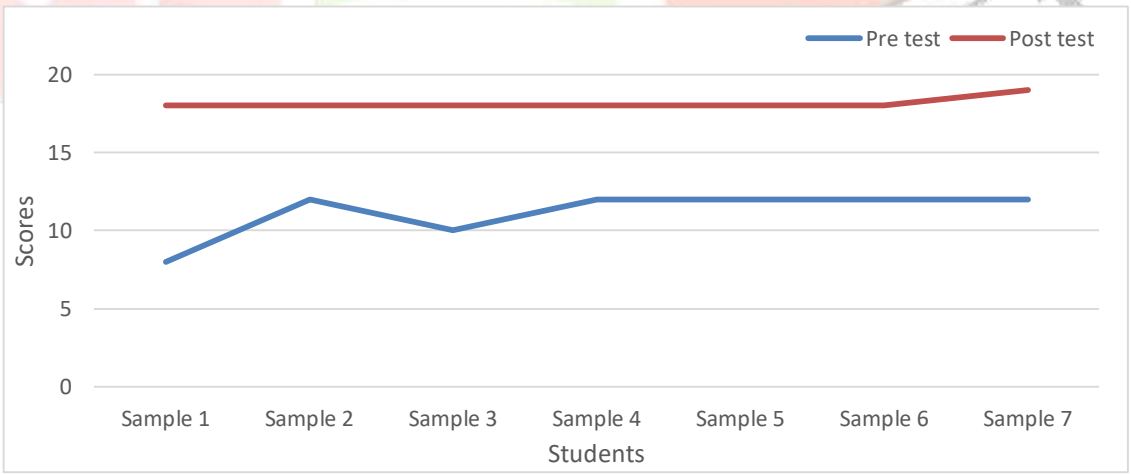

Figure -1: Line graph of Pre-Test and Post-Test Scores

Interpretation of Result

The analysis of student performance shows a remarkable improvement after the intervention. In the **pre-test**, the seven students scored **8, 12, 10, 12, 12, 12, and 12**, with an **average score of 11.14**. After implementing the action plan, their **post-test scores** rose to **18, 18, 18, 18, 18, 18, and 19**, giving an **average of 18.14**. The **average gain** was **7 marks**, showing an overall improvement of about **35–50%**. This steady rise in marks indicates that the activities such as charts, flashcards, and problem identification games significantly enhanced students' conceptual understanding. The consistent improvement across all samples confirms that **activity-based learning** helped students recall formulas better and apply them correctly in solving numerical problems in physics.

Research Findings

1. The visual representation strengthened their analytical skills and improved retention of key steps.
2. The conducted activities helped to motivate students and develop their interest in the topic.
3. Activities and strategies enhanced their conceptual understanding and recall ability.
4. Four targeted activities were conducted to improve their problem-solving ability related to solving numerical problems in physics.
5. The practice improved their accuracy, logical reasoning and confidence in handling physics numerical problems.
6. Activity based learning made students actively participate in the learning context.

Suggestions

1. **Strengthen Conceptual Understanding**: Teachers should focus on facilitating students' understanding of the concepts behind formulas, instead of memorizing them, to help identify the correct formula easily.
2. **Improve Mathematical Skills**: Strengthening basic math skills in algebra, trigonometry, and arithmetic helps students handle formulas and numerical problems effectively.
3. **Provide Sufficient Practice Opportunities**: Regular practice of numerical problems, from simple to complex, builds confidence and enhances students' problem-solving ability.
4. **Enhance Teaching Methodology**: Teachers should use interactive, student-centered methods like demonstrations and real-life examples to improve understanding.
5. **Encourage Analytical Thinking**: Training students to analyze and interpret problem statements carefully helps them choose the right formula accurately.
6. **Use Visual Aids and Formula Charts**: Flowcharts, diagrams, and formula maps make learning easier by showing connections between related physics concepts.
7. **Offer Remedial Support and Peer Learning:** Special coaching and peer tutoring help weaker students improve their understanding and problem-solving skills.
8. **Foster Positive Attitude and Motivation Toward Physics**: Encouraging curiosity and showing real-world applications of physics increase students' interest and persistence in learning.

LIMITATIONS OF THE STUDY

1. The study was restricted to a small sample of seven 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 and was confined to a single school.

Conclusion

The study revealed that high school students face significant difficulties in selecting and applying correct formulas to solve numerical problems in physics due to weak mathematical skills, lack of conceptual understanding, and limited practice. The implementation of activity-based learning strategies such as charts, flashcards, and problem identification games helped students understand concepts better, apply formulas accurately, and gain confidence in problem-solving. The improvement in post-test scores demonstrated that interactive and well-planned teaching interventions can effectively enhance students' learning outcomes and interest in physics.

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