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Breaking Down The Barrier: A Study On Students Struggles With Force And Laws Of Motion Numerical

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ABSTRACT

This action research investigates the challenges faced by secondary school students in solving numerical problems related to Force and Laws of Motion in Physics. Despite understanding the theoretical concepts, many students struggle to apply them effectively due to issues such as memorization without comprehension, poor visualization skills, confusion with sign notations and weak connections between real-life situations and numerical problems. A sample of 12 students from Kannika Cauvery School, Mysuru, was selected. A pre-test was conducted to assess their existing problem-solving skills, followed by intervention strategies including role play and visualization and simulation techniques. After the intervention, a post-test was administered to measure improvement. Statistical analysis revealed that the mean score increased from 4.66 to 13, indicating a 41.12% improvement in performance. The findings highlight that interactive and visual learning strategies effectively bridge the gap between theory and application, enhance students' problem-solving skills and reduce anxiety associated with numerical problem solving. This study emphasizes the importance of innovative teaching methods in strengthening conceptual understanding and promoting active engagement in Physics classrooms.

Keywords: Numerical problem solving, Force and Laws of Motion, Visualization, Conceptual Understanding, Teaching Strategies, Problem-Solving Skills.

INTRODUCTION

Many students find numerical problem-solving in physics challenging despite understanding theoretical concepts. This gap between theory and application arises from factors such as weak mathematical skills, difficulty in selecting appropriate formulas and misinterpreting problem statements. The complex language of questions and poor visualization skills further hinder their ability to model problems effectively. Repeated failure leads to frustration, loss of confidence and reduced motivation. These barriers not only affect problem-solving but also diminish overall engagement with physics. Addressing these issues through effective teaching strategies can bridge the gap between theory and practice, enhancing students' conceptual understanding, confidence and analytical skills.

NEED AND IMPORTANCE

Solving numerical problems in physics strengthens students' conceptual foundation and analytical skills. Regular practice reinforces core concepts, boosts exam performance and builds confidence. It reduces fear and anxiety toward physics by addressing learning difficulties early. Numerical work promotes conceptual clarity through application rather than rote memorization, bridging theory and real-life situations. It also sharpens mathematical skills like algebra and unit conversion. Most importantly, mastering basic numerical skills prepares students for advanced physics topics, fostering confidence and a positive attitude towards the physics curriculum.

STATEMENT OF THE PROBLEM

The main purpose of the study is to know the challenges faced by the students and abstractness of the concept. The whole concept is based on the visualization which may cause difficulty in solving the problems among the children.

CAUSES OF THE PROBLEM

1. **Fast paced curriculum**: Lack of time management in schools to conduct activities and too much syllabus burden for the teachers and to the learners.
2. **Memorization of the formula without understanding:** Focusing on memorizing the formulas instead of understanding that.
3. **Poor visual representation of the problem:** The teachers and students are failing to visualize the problems, which causing lack of learning.
4. **Complex language may create confusion:** Sometimes the physics terms and language may create confusion and complexity among the learners.
5. **Confusion in the sign notations:** Learners get confused while solving the problems by using wrong sings (+ and –) which results the wrong answers.
6. **Lack of real-world connection while solving the problems:** Learners and teachers are struggling to connect the real-world situations with numerical which becoming the barrier.
7. **Poor understanding of concepts:** To solve the problems concept understanding is very important, lacking in concept understanding failing in solving the numerical.
8. **Fear of mathematics:** Physics numerical often mathematics skills, but most of the secondary school students have fear of mathematics which effects on the physics numerical solving.
9. **Traditional method of teaching and learning:** To solve the physics numerical traditional method is not a suitable method for tackle this problem among present generation learners.

PRIORITIZED CAUSES

1. Memorization of the formula without understanding.
2. Poor visual representation of the problem.
3. Confusion in the sign notations.
4. Lack of real-world connection while solving the problems.

OBJECTIVES OF THE STUDY

1. To identify the difficulties faced by the students in solving numerical on force and laws of motion.
2. To design strategies to improve conceptual understanding and problem-solving skills.
3. To implement strategies to improve conceptual understanding and problem-solving skills.
4. To assess the effectiveness of the implemented strategies in understanding among the students.

REVIEW OF RELATED LITERATURE

Nadapdap, A. T. Y., & Istiyono, E. (2020) conducted a study to develop a Physics Problem-Solving Skills (PSS) test for Grade X senior high school students that meets the required standards of validity and reliability. The development process involved three main stages: test designing**,** test trial and test revision and preparation**.** The design stage included needs analysis, mapping, defining test purposes and competencies, selecting materials, preparing answers, writing items, validating content, improving the test and preparing the scoring guide using the Partial Credit Model (PCM). The trial stage included selecting subjects, administering the test and analyzing results using Item Response Theory (IRT). The study was conducted in Kulonprogo with a sample of 281 students. The results indicated strong content validity with Aiken's V ranging from 0.95 to 0.98**.** Based on INFIT MNSQ criteria, 52 items fit the PCM model, with difficulty indices ranging from -1.47 to 0.88. Information function analysis and SEM confirmed the test's suitability for measuring abilities between -1.3 and 2.7. Thus, the developed instrument was found to be valid, reliable and feasible for assessing physics problem-solving skills in high school students.

Sartika, D., & Humairah, N. A. (2018) conducted a study to emphasize the importance of problem-solving skills in physics learning, focusing on how students apply concepts rather than just memorize them. The research aimed to analyze students' abilities using Polya's four-step model: understanding the problem, planning, execution and reviewing the solution. The study involved college students of the Physics Education Department who had completed modern physics. Using a qualitative descriptive method**,** data were collected through problem-solving tasks and analyzed to identify learning gaps. Results showed that most students could understand problems but faced difficulties in selecting strategies and applying them correctly. Many also neglected the review stage, limiting their ability to self-correct. The study concluded that structured problem-solving instruction enhances conceptual clarity, analytical thinking and confidence. It recommended integrating Polya's framework into classroom practices to bridge the gap between theory and application in physics.

Awodun, A. O. (2015): The study investigated the Effects of Problem-Solving teaching Strategy on secondary school students' academic achievement in Physics in Ekiti State, Nigeria. The study employed two-group pretest-posttest quasi experimental design comprising of one experimental (Problem-Solving) group and a control group. Purposive and stratified random sampling techniques was used to select a total sample of 120 SS II Physics students (this sample was divided into experimental and control groups in ratio 1:1) from three Senior Secondary Schools in Ekiti West Local Government Area, Ekiti State. Three null hypotheses were formulated and tested at 0.05 level of significance. The instrument for this study was Physics Achievement Test (PAT) and the treatment packages used for the study was Problem-Solving Instructional Package (PSIP). The data collected were analyzed using t-test and ANCOVA statistical analysis packages. The results of the analyses showed that no significant difference existed between academic achievement of students in experimental group and control group involved in the study at pretest (this indicated initial academic homogeneity of the groups). However, students' achievement in the experimental group and control group at post-test level was found to be significantly different in favor of the experimental group. This showed that Problem-Solving teaching strategy significantly influenced students' academic achievement in Physics in Senior Secondary School. Based on the findings of the study, conclusion and recommendations were made.

Finegold, M., & Mass, R. (1985) investigated how grade twelve advanced physics students solve written physics problems by comparing good problem solvers (GPS) and poor problem solvers (PPS)**.** GPS were identified by teachers as achieving at least 90% in physics, while PPS scored above 60% but struggled with problem solving despite having the required knowledge. Participants solved four physics problems and were asked to think aloud, allowing researchers to analyze problem translation, planning, solution methods, checking and time allocation. Using Polya's four-step problem-solving model, the study examined differences in strategies and approaches, revealing that GPS planned more effectively, checked solutions carefully and allocated time efficiently, whereas PPS often rushed steps and misapplied methods, highlighting the cognitive processes underlying problem-solving proficiency.

RESEARCH METHODOLOGY

In the present study, Quantitative Research method and Experimental research design is used.

Sampling: The sample consists of 12 Students studying in 9th Standard of Kannika Cauvery School, located at Hebbal Area of Mysuru City, which belongs to Hebbal cluster of North Block of Mysuru District.

Research Tool: Researcher developed Questionnaire for Pre-Test and Post-Test. Questionnaire consists of both objective and descriptive type questions with the maximum marks of 20.

PROCEDURE

The following phases have been involved in the present action research:

1. Finding the problem and selection of school for action research study
2. Preparation of Pre-test and Post-test Question paper
3. Conducting Pre-test
4. Identifying the Sample

5. Designing and adopting frequent practices
6. Conducting Post-test
7. Comparing the performance of the students in Pre-test and Post-test
8. Enlisting the Findings
9. Stating Research based suggestions

To substantiate the above phases, the researcher conducted the Pre-test to check the prior knowledge of the students on solving a numerical. On this basis the researcher conducted "Role Play" and "Visualization and Simulation" techniques to enhance the understanding level and visualization of the numerical followed by the post-test to know the effectiveness of the strategies.

ACTION PLAN

Table 1: Details of Action Plan

Sl. No.	Activities	Duration	Days
01.	Role play of the numerical	40 min	2
02.	Visualization and simulation	40 min	2

DESCRIPTION OF ACTION PLAN:

1. **Role Play:** To enhance student engagement and deepen understanding, the researcher applied the role-play technique as an innovative method for teaching numerical problems in physics. Rather than relying solely on traditional lecture-based instruction, this approach allowed students to actively participate in dramatized scenarios that mirrored real-life situations related to the numerical concepts being taught. This technique allowed the learners to participate in the learning activities, which makes the solving numerical easier. Overall, this method proved to be a powerful tool in transforming numerical problem-solving from a source of anxiety into an engaging and meaningful learning experience.

2. **Visualization and Simulation:** To enhance conceptual clarity and make numerical problem-solving more accessible, the researcher incorporated visualization techniques into the teaching process. This approach involved the use of visual aids. By observing the visual examples, the learners are actively participated in the learning activity. This method significantly reduced cognitive load and helped the learners to view the numerical in different point of view. Visualization also catered to diverse learning styles, especially for visual learners who benefit from seeing information rather than hearing or reading it. As a result, students found it easier to interpret problem statements.

DATA ANALYSIS:

Table 2: Statement of Students Performance

Sl. No.	Name of the Students	Scores		Difference	% of improvements
		Pre -Test	Post-Test		
1	Student No. 1	08	19	11	55
2	Student No. 2	07	16	09	45
3	Student No. 3	10	16	06	30
4	Student No. 4	01	11	10	50
5	Student No. 5	08	16	08	40
6	Student No. 6	01	11	10	50
7	Student No. 7	02	13	09	45
8	Student No. 8	04	12	08	40
9	Student No. 9	01	09	08	40
10	Student No. 10	08	11	03	15
11	Student No. 11	03	10	07	35
12	Student No. 12	02	12	10	50

Pre-Test Statistical Analysis:

Table 3: Statistical analysis of Pre-Test

Class Interval	Frequency (f)	Midpoint (x)	fx	Cumulative frequency
00-01	3	0.5	01.5	3
02-03	3	2.5	07.5	6
04-05	1	4.5	04.5	7
06-07	1	6.5	06.5	8
08-09	3	8.5	25.5	11
10-11	1	10.5	10.5	12
12-13	0	12.5	0	12
14-15	0	14.5	0	12
16-17	0	16.5	0	12
18-19	0	18.5	0	12
20-21	0	20.5	0	12
	n=12		**∑fx=56**	

Central Tendency: Mean = 4.666, Median = 3.5, Mode = 1.18

Post-Test Statistical Analysis:

Table 4: Statistical Analysis of Post-Test

Class Interval	Frequency (f)	Midpoint (x)	fx	Cumulative Frequency
00-01	0	0.5	0	0
02-03	0	2.5	0	0
04-05	0	4.5	0	0
06-07	0	6.5	0	0
08-09	1	8.5	8.5	1
10-11	4	10.5	42	5
12-13	3	12.5	37.5	8
14-15	0	14.5	0	8
16-17	3	16.5	49.5	11
18-19	1	18.5	18.5	12
20-21	0	20.5	0	12
	n=12	**∑fx=156**		

Central Tendency: Mean = 13, Median = 13, Mode = 13

GRAPHICAL REPRESENTATION

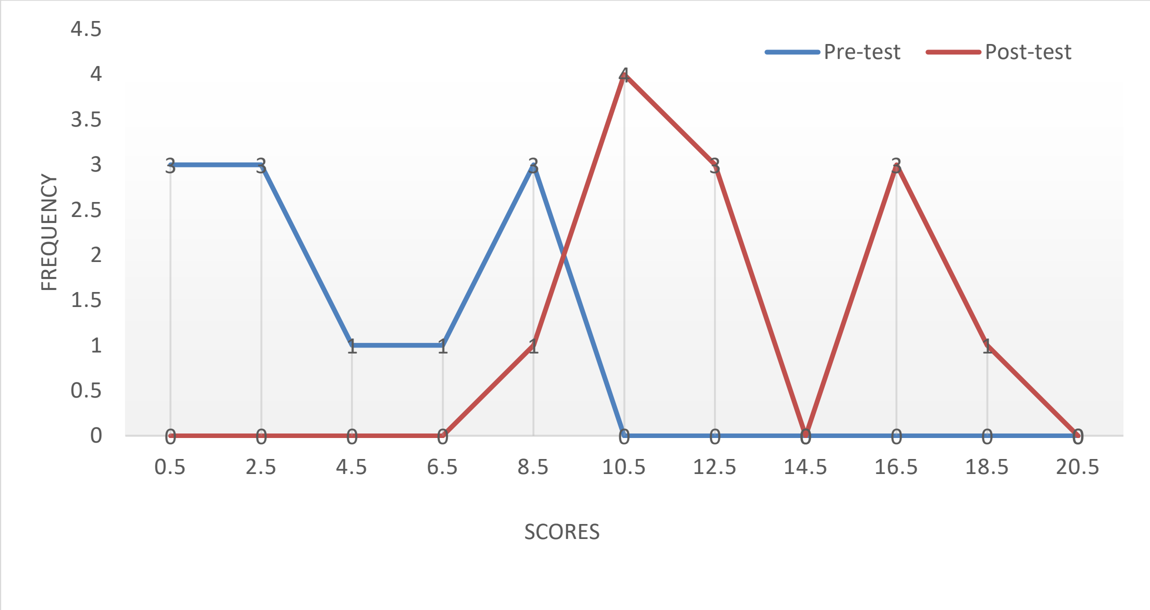

Fig1: Graph showing the effectiveness of the action plan

INTERPRETATION

By analyzing the data, the average score of the learners in the pre-test is **4.66**. After the action plans, the learners have improved in the learning process and got **13** as the average score in post-test, so we can find that the pupils are relatively performed well in the post-test when compared to the pre-test. The activities which are conducted are very fruitful for the learner's growth.

FINDINGS

1. After pre-test, researcher analysed learners are struggling in doing simple mathematical operations.
2. Understanding the numerical are the most difficult for the learners in pre-test. But in post-test learners have understood the numerical, when compared to the pre-test.
3. Role playing the numerical, plays the vital role in the understanding the statement numerical, which helped the learners to push their limits in terms of solving the numerical.
4. Visualization of the numerical created the other way of thinking the numerical and it helped the learners to analyse the statement and to solve easily.
5. Whole class learning is improved and learnt the new ways of understanding, analysing and solving the numerical with ease.

SUGGESTIONS

1. Visualization of the numerical should be done by the teacher using the visual aids, which help the learners to understand the problem and it fosters the analytical thinking in the learners.
2. Teacher should use the Artificial Intelligence and digital tools to give visual experience of the numerical statement to the learners for better understanding.
3. Role plays for the simple numerical have to be performed which retains in the memory for the longer time. After enacting numerical, let the students to calculate the force, acceleration or mass using the formulae. This bridges physical experience with numerical application.
4. Make sure that each role-play targets the specific concepts, so students get no confusion.
5. Teacher should teach the basic mathematical operations to the learners like changes of the sign when the terms are transferred from the LHS and RHS, by practicing the rearrangement of formulas and solving simple equations step-by-step.
6. Relate the numerical into the real-life situations like while doing simple works learners can relate to direction of forces acting, net force and momentum.
7. Teach students to identify knowns and unknowns, choose the right formula and solve the numerical systematically.

LIMITATIONS OF THE STUDY

1. The study involved a small group of 12 students.
2. It was conducted in only one school.
3. The intervention was carried out over a short period.
4. Only numerical on Force and Laws of Motion were included.
5. Individual differences among students were not deeply explored.

SCOPE FOR FUTHER RESEARCH

1. The study can be conducted with more students from different schools.
2. Other physics topics can be included to test problem-solving strategies.
3. Long-term effects of role play and visualization on learning can be studied.

CONCLUSION

This research investigates the challenges learners face when solving numerical problems related to the topic Force and Laws of Motion in physics. These challenges often act as cognitive barriers, impeding not only the understanding of core concepts but also diminishing overall engagement and confidence in the subject. Recognizing the critical role these numerical play in developing analytical thinking and scientific reasoning, the study aims to identify effective strategies to overcome these obstacles. Learners actively participated in dramatized scenarios that illustrated real-life applications of forces and motion. Visualization through the pictures and video also done. This brought the learners from the passive participation to the active learning. The researcher found that 41.12% improvement among the learners. This study helps educators to understand the struggles of the learners in solving the physics numerical.

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