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Enhancing Conceptual Understanding Of Mass And Weight Among Secondary School Students

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ABSTRACT

This study aims to enhance the understanding of the concepts of mass and weight among secondary school students. Although these are fundamental ideas in physics, many students continue to confuse them because the terms are often used interchangeably in everyday life. The research was conducted among Class IX students of Rotary West School, Mysuru, with the objective of identifying and correcting these misconceptions. A quantitative approach was adopted, using a one-group pre-test and post-test design. Six students were selected through purposive sampling. To make learning more meaningful and engaging, the researcher implemented several activities including concept comparison, a spring balance experiment, a unit identification game and situational analysis. An achievement test developed by the researcher was used to assess students' understanding before and after the intervention. The results showed a clear improvement, with average scores rising from 5.33 in the pre-test to 15.33 in the post-test, reflecting about a 50% increase in conceptual understanding. The findings indicate that activity-based and experiential learning approaches help students distinguish between mass and weight more effectively and connect these ideas to real-life contexts. The study concludes that incorporating practical, interactive and student-centered methods in science teaching can significantly reduce misconceptions and promote deeper, more meaningful learning. It also highlights the need for teachers to focus on developing conceptual clarity rather than relying solely on rote learning.

Keywords: Mass, Weight, Misconceptions, Activity-Based Learning, Experiential Learning.

Introduction

Understanding the concepts of mass and weight is fundamental to the study of physics and science. However, research has shown that many students struggle to differentiate between these two concepts, leading to misconceptions and difficulties in applying them to real-world problems. This challenge is particularly significant among secondary school students, who are at a critical stage of developing their scientific

knowledge and skills. The confusion often arises because both terms, mass and weight, are commonly used interchangeably in non-scientific contexts, which affects students' conceptual clarity when learning science formally. Such misconceptions can hinder their ability to grasp related topics such as force, motion and gravitation. Therefore, developing a clear understanding of the distinction between mass and weight becomes essential not only for academic success but also for building a foundation for higher studies in physics. By addressing these misconceptions through practical activities and guided exploration, students can move beyond rote memorization and achieve meaningful learning of scientific concepts.

Need and Importance of the study

A clear understanding of mass and weight is essential for learning physics and related sciences. However, many secondary students hold misconceptions and use these terms interchangeably, hindering scientific understanding and application. Addressing these misconceptions builds a strong conceptual foundation, promotes analytical thinking, enhances problem-solving and fosters interest in STEM, contributing to the development of scientifically literate and innovative citizens.

Statement of the Problem

Despite being fundamental concepts in physics, many secondary school students struggle to distinguish between **mass** and **weight**, leading to misconceptions and poor application in real-life contexts. This study seeks to identify the nature and extent of these misunderstandings and explore effective strategies to enhance students' conceptual clarity and scientific reasoning.

Objectives of the Study

1. To assess the current level of students understanding on mass and weight.
2. To identify specific misconceptions related to mass and weight using pre-test responses and classroom observations.
3. To implement concept-based teaching strategies to improve understanding and eradicate misconceptions on mass and weight.
4. To evaluate the effectiveness of interventions.
5. To enlist research based suggestions for the teachers to enhance the Conceptual understanding of Mass and Weight among the students.

Causes of the Problem

1. Students confuse mass and weight due to similar usage in natural language.
2. Lack of hands-on activities to demonstrate the difference between mass and weight.
3. Teaching methods rely heavily on rote learning rather than conceptual understanding.
4. Inadequate emphasis on units and measurement techniques.
5. Limited use of visual aids or real-world analogies in explaining the concepts.
6. May struggle with scientific terminology and concepts.
7. Instruction may focus too much on formulas and calculations, rather than conceptual understanding.
8. Language barriers.

Prioritized Causes

The most critical causes identified are:

1. Confusion in mass and weight due to similar usage in natural language.
2. Rote learning practices over conceptual teaching.
3. Lack of hands-on demonstrations.
4. Limited use of analogies and visual aids.

Review of related Literature

Rosli N and Nasir N M (2017): "The Use of the Process-Oriented Guided Inquiry Learning (POGIL) Approach to Address Form One Students' Misconceptions about Weight and Mass." This study investigated weight and mass are two fundamental physics concepts that students need to master prior to learning more advanced physics concepts. These two concepts have been taught to students beginning from primary level and at the lower secondary level. The teaching of these concepts was conducted using various instructional strategies. Despite concerted efforts by teachers, students still retained various misconceptions about these concepts. Among various constructivist-based learning approaches, process-oriented guided inquiry learning (POGIL) has been identified as an effective approach in reducing misconceptions and improving learning. In this study, POGIL was used to remediate Form 1 (equivalent to grade 7) students' misconceptions about weight and mass. Findings of ANCOVA analysis indicate that there was significant difference between the post-test mean scores of the experimental (M exp = 3.64; SDexp = 0.49) and comparison groups (Mcom = 5.32; SDcom = 0.78) with the result favoring the former. Furthermore the paired samples t-test and interview responses show that POGIL has reduced the misconceptions to a certain extent.

Sarabando C and others (2016): "Improving Students' Understanding of the Concepts of Weight and Mass with a Computer Simulation." Although weight and mass are considered fundamental concepts in physics, they are still not well understood by students. A computer simulation was designed to improve students' learning of these concepts and compared it with other teaching strategies. The research was carried out with 142 students (7th grade; 12-13 years old), from three schools. There is a significant change in conceptual understanding of the concepts weight and mass for all groups. Nevertheless, total gains were higher for students who used the computer simulation. The implication is that using a computer simulation, carefully designed to address specific conceptual difficulties and may help the students understand the concepts of weight and mass. They also interviewed teachers to understand their role in the classroom. It was found that the features most likely to contribute to improve students' learning are related to the balance between support and autonomy given to students during the use of the computer simulation.

Mullet E (1990): "Distinction between the Concepts of Weight and Mass in High School Students." Three experiments were designed to test high school students' intuitive mastery of the concepts of mass and weight. The theoretical framework used is Information Integration Theory. Results indicate that, regardless of age, students possess two distinct concepts corresponding to each of these notions. However, the terms mass and weight are both understood in terms of one concept, that of weight (f of volume,

density, gravitation), whereas the term 'amount of matter' is clearly related to the concept of mass (f of volume, density).

Research Methodology

In the present study, Quantitative Research Method is adopted. Experimental research design (One group pre-test post-test design) is employed.

Population: The population of the study is 9th Standard students of Rotary West School, located in Saraswathipuram, Mysuru. The school belongs to Kuvempunagar Cluster, South Block of Mysuru District.

Sampling: The Sample of the study is 6 students of the said school based on purposive sampling technique, who faced difficulties in understanding the concept of mass and weight.

Research Tool:

Researcher developed Achievement Test Questionnaire consisting Objective types and Short answers questions with the maximum marks of 20, is used for Pre-Test and Post-Test.

Procedure of Action Research

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 Questionnaire
3. Conducting Pre-test
4. Identification of the Samples
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.

Action Plan

Table-1: Details of Action Plan

Sl. No.	Activity	Duration	Day
1	Comparison	40 min	1 day
2	Spring balance experiment	40 min	2 days
3	Unit identification game	40 min	1 day
4	Situational Analysis	40 min	2 days

Description of Action Plan

1. **Comparison:** Researcher initiated the activity by clearly defining the concepts of mass and weight. Researcher explained that mass is the measure of the amount of matter present in a body, whereas weight is the force exerted on that body due to gravity. After that, Researcher discussed the key differences between the two, helping students understand that while mass remains constant everywhere, weight varies depending on the gravitational pull of the place. Furthermore, Compared the different units used to measure mass and weight- such as kilograms and grams for mass and newtons for weight. To make the concept more relatable examples like how an object's mass remains the same on both Earth and in space, but its weight changes due to differences in gravitational force were given. This comparison helped students to clearly distinguish the two terms and strengthened their conceptual understanding.

2. **Spring balance experiment:** Researcher conducted an experiment using a spring balance to demonstrate the relationship between mass and weight. Firstly, it was ensured that the spring balance is properly calibrated by setting it to zero before any measurement is taken. Then, Researcher attached an object of known mass to the spring balance and recorded the corresponding reading. After that, Researcher repeated the process using an object of unknown mass, such as a small toy and carefully noted the readings. To ensure the accuracy of the results, Researcher repeated the steps two to three times and compared the measurements. Through this experiment, students were able to observe firsthand how the spring balance measures the weight of an object and how it can be used to determine the mass when the gravitational field is known.

3. **Unit identification game:** To make the learning process more interactive, Unit identification game was organized for the students. For this activity, Game cards and worksheets were provided to the students that included different physical quantities and their respective units. Students were asked to match each quantity with its correct unit. For instance, mass with kilograms or grams and weight with newton. As they matched the pairs, Points were awarded for every correct answer to encourage active participation. Later, Students were invited to discuss their reasoning behind each match, which led to a lively and meaningful exchange of ideas. This activity not only reinforced their understanding of the correct units but also developed their ability to think critically and collaboratively.

4. **Situational Analysis:** Researcher led a discussion on 'Real-world situations where mass and weight play a crucial role'. Researcher presented visual aids related to astronautics, construction and sports to capture students' interest and spark curiosity. Following this, an open discussion on how mass and weight are significant was held. Several topics like how an astronaut's weight changes in different gravitational environments, while their mass remains constant and so on was discussed. Together, analyzed the implications of these differences and discussed why understanding of mass and weight is important in practical scenarios. Students were encouraged to share their own thoughts and perspectives, which made

the discussion lively and insightful. This activity helped them realize how physics concepts are directly linked to everyday life and modern technology.

Data Analysis

Table-2: Statement of Students Performance

Sl. No.	Name of the student	Score		Difference	% of improvement
		Pre-test	Post- test		
1	Student A1	5	16	11	55
2	Student A2	5	16	11	55
3	Student A3	5	13.5	8.5	42.5
4	Student A4	5	15.5	10.5	52.5
5	Student A5	4	11.5	7.5	37.5
6	Student A6	4	15	11	55

Graphical Representation

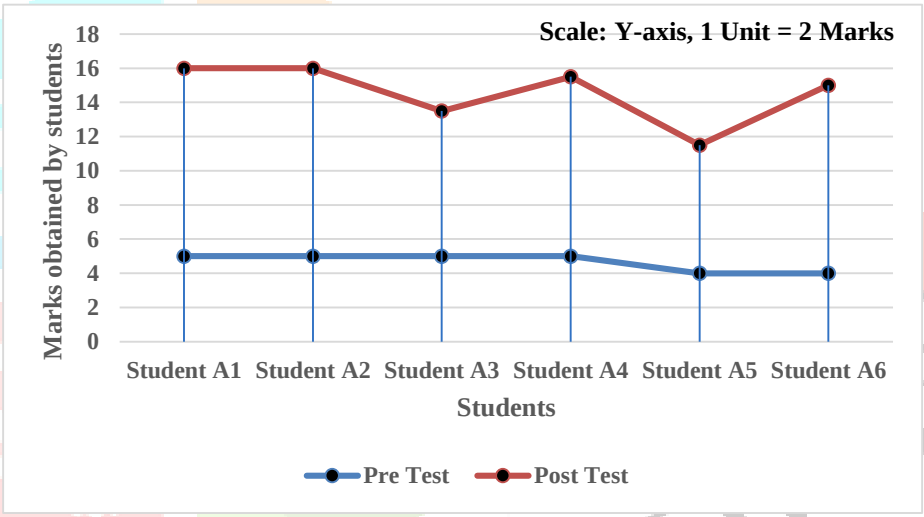

Figure-1: Graphical representation of Students Scores

Interpretation

By analyzing the data, the average score of the samples in pre-test is 5.33. After conducting the activities, the samples are improved and average score in post-test is 15.33. From this we can find that samples have improved and performed well in the post test when compared to pre-test.

Findings

1. Students were able to correct their earlier misconception that mass and weight are the same, as clarified through the first activity.
2. Students reported that performing the spring balance experiment made learning more enjoyable and meaningful.
3. Many students expressed that engaging in practical activities helped them remember the concepts better than reading from textbooks alone.
4. The activities helped students visualize and understand the difference between mass and weight more clearly.

5. Students found it interesting to learn that their weight would be less on the Moon, while their mass remains unchanged.

Implications of the activities

1. **Comparison:**
    - Helped students correct the common misconception that mass and weight are the same.
    - Enabled students to understand the proper use of units and relate them to real-life examples.
    - Improved students' conceptual clarity through direct comparison and discussion.
2. **Spring balance experiment:**
    - Allowed students to practically observe how weight varies with gravity.
    - Helped them connect theoretical learning with hands-on experience.
    - Increased students' interest and confidence in performing scientific experiments.
3. **Unit identification game:**
    - Reinforced students' understanding of the correct units for mass and weight.
    - Made the learning process more interactive and helped retain the concept better.
    - Promoted teamwork and active participation among students.
4. **Situational Analysis:**
    - Helped students relate scientific concepts to real-life situations.
    - Encouraged deeper thinking about how mass and weight change in different environments.
    - Developed students' ability to apply theoretical knowledge to practical contexts.

Suggestions

1. Teachers should clarify students' common misunderstanding that mass and weight are the same at the beginning of the lesson to prevent confusion in later learning.
2. Instead of only explaining gravity in theory, use real-life examples such as an astronaut on the Moon or objects in space to show how weight changes while mass remains the same.
3. During teaching, explicitly emphasize the units used for mass (kilograms, grams) and weight (newtons) so students can correctly identify and apply them in problems and experiments.
4. Incorporate simple practical activities, like measuring objects with a spring balance, to help students observe the difference between mass and weight in a concrete way.
5. Use games, discussions or matching activities to actively involve students in learning, which helps them understand and remember the concepts better.

Conclusion

This study is focused on the understanding the concepts of mass and weight among the learners, the misconception may affect the whole learning experience of the learner, by performing these activities like unit identification game and spring balance experiment, the researcher found that 50% improvement among the learners. This study helps the educators to clarify the misconception among learners and teach them basic concepts in a lively manner.

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