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A Study on the Difficulties of 9th Standard Students in Balancing Chemical Equations

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Abstract

Balancing chemical equations is a fundamental skill in chemistry, essential for understanding the law of conservation of mass. However, 9th standard students often face difficulties due to weak conceptual understanding, limited mathematical skills, reliance on rote learning, and inadequate exposure to interactive teaching methods. This study investigates the specific problems students encounter while balancing chemical equations and explores effective pedagogical strategies to enhance conceptual understanding and problem-solving abilities. Using a quantitative research method with an experimental design, a sample of six 9th standard students from Kamadhenu Convent, Mysore, participated in an action research intervention. Five interactive activities, including storytelling, equation puzzle cards, hands-on atom models, "What's Missing?" games, and error detective exercises, were implemented. Pre- and post-tests were conducted to assess learning outcomes. Findings indicate significant improvement in students' ability to recognize and balance chemical equations, develop logical reasoning, and engage actively in learning. The study concludes that activity-based, visual, and stepwise teaching strategies effectively reduce misconceptions, increase confidence, and foster mastery in balancing chemical equations. Recommendations include regular practice, peer learning, and reinforcement of the law of conservation of mass to support conceptual clarity and sustained learning in chemistry.

Keywords

Balancing chemical equations, Conceptual understanding, Activity-based learning, Problem-solving skills

Introduction

Balancing chemical equation is a fundamental skill in chemistry that ensure the law of conservation of mass is upheld in chemical reaction for 9th standard students. Often present significant challenges due to its abstract nature and mathematical reasoning involved. Many students struggle with identifying chemical formulas, placing correct co-efficient and understanding the underlying principles, these difficulties can hinder their overall interest and performance in science. This study aims to investigate the specific problems faced by students while balancing chemical equation and to explore effective teaching strategies that can enhance their conceptual understanding and problem-solving abilities in chemistry.

Need and Importance of the Study

Balancing chemical equations is a fundamental chemistry skill, yet many 9th standard students struggle due to weak understanding of atoms, molecules, valency, and the law of conservation of mass. Lacking this foundation, they depend on memorization instead of logical reasoning, leading to frequent errors. Since this skill supports higher-level topics like stoichiometry and mole concepts, early intervention is essential. Identifying students' difficulties through action research helps teachers refine strategies, support slow learners, and improve overall classroom learning.

Causes of the Problem

1. **Lack of conceptual understanding:** Many students do not fully grasp the law of conservation of mass which is essential for balancing equation.
2. **Weak foundation in basic chemistry**: To adequate understanding of chemical symbols formulas and valency affect their ability to form and balance equation.
3. **Poor mathematical skill**: Balancing equation often requires simple arithmetic and logical reasoning which some students facing challenges.
4. **Rote learning approach**: Students often tiny to memorize chemical equation instead of understanding the process
5. **Limited exposure to practice**: Insufficient classroom time or lack of practice exercise prevent student from developing fluency and skill of balancing chemical equation.
6. **Teaching method**: Traditional lecture-based teaching without the use of visual aids, models or interactive tools fails to engage students in chemistry learning effectively.

Prioritized Causes

1. Lack of conceptual understanding.
2. Weak foundation in basic chemistry.
3. Poor mathematical skill.
4. Rote learning approach.
5. Limited exposure to practice.

Objectives of the Study

1. To assess the current level of students' understanding of balancing chemical equations.
2. To develop pedagogical strategies to simplify the process of balancing chemical equations.
3. To implement the developed strategies among 9th standard students.
4. To evaluate the effectiveness of the implemented strategies on students' ability to balance chemical equations.
5. To recommend effective teaching methods to facilitate the balancing of chemical equations among 9th standard students.

Review of Related Literature

Ogubdiji (2024) investigated students' difficulties in balancing chemical equations in selected senior secondary schools. Using a descriptive survey design, the study employed diagnostic tests, classroom observations, and interviews with 40 students from SS I and SS II and four chemistry teachers. Results revealed that many learners had weak conceptual understanding of the law of conservation of mass, relied heavily on rote memorization, and struggled to distinguish coefficients from subscripts. Students also lacked foundational knowledge, were confused by symbolic representations, and had limited exposure to practical demonstrations. The study recommended strengthening conceptual learning through activity-based methods, models, storytelling, and regular practice. It also emphasized step-by-step instruction, digital simulations, continuous assessments, and individualized support for slow learners. Overall, the study concluded that improved pedagogical strategies and reinforcement of basic principles can significantly reduce students' difficulties and improve achievement in balancing chemical equations.

Emeka and Njoku (2023) investigated the impact of the inquiry teaching method on students' achievement in writing and balancing chemical equations. Using a quasi-experimental design with pre- and post-tests, the study involved 80 junior secondary students divided into an inquiry-based experimental group and a traditional lecture control group. The inquiry group participated in hands-on activities, guided questioning, collaborative experiments, and problem-solving tasks that helped them understand the conservation of mass through direct observation. Results showed that these students outperformed the control group in writing correct chemical formulas, identifying reactants and products, and balancing equations through logical reasoning rather than memorization. They also demonstrated higher motivation, better retention, and increased confidence. The study recommended teacher training in inquiry strategies, improved laboratory resources, group-based exploration, and continuous formative assessment. Overall, inquiry teaching proved highly effective in enhancing students' conceptual understanding and achievement in chemical equation writing and balancing.

Thangavel (2019) conducted an experimental study to identify effective teaching techniques for helping Class 9 students balance chemical equations. Sixty students were divided into an experimental group taught through storytelling, colour-coding, demonstrations, and stepwise guided practice, and a control group taught traditionally. Results showed that the experimental group achieved higher scores, demonstrated a clearer understanding of the law of conservation of mass, made fewer errors, and showed greater confidence and engagement. Visual aids, structured worksheets, and peer-learning activities were found particularly useful. The study recommended activity-based learning, digital simulations, regular graded practice, and teacher training to enhance students' mastery of balancing chemical equations.

Assafuah-Drakow (2018) examined how supportive instructional strategies can improve students' performance and attitude toward balancing chemical equations. Using an action research design, the study implemented interventions such as concept mapping, guided practice worksheets, peer collaboration, and real-life analogies to help students visualize the conservation of atoms. The sample included 35 lower secondary science students, allowing close monitoring of their learning challenges. Initial findings showed

that students lacked confidence, misunderstood coefficients, and relied on guesswork. After the interventions, students demonstrated significant improvement in accuracy, logical reasoning, and problem-solving skills. Their attitude also became more positive as the activities made learning interactive and less intimidating. The study recommended using visual and hands-on tools, encouraging students to verbalize balancing steps, integrating short reinforcement quizzes, and providing teacher training in innovative pedagogy. Overall, the interventions effectively enhanced both student performance and attitude in chemical equation balancing.

Charnock (2016) examined effective teaching methods for balancing chemical equations by comparing an inspection approach with an algebraic, step-based method. Using a mixed qualitative–quantitative design, the study included classroom interventions, worksheets, pre-tests, post-tests, and teacher–student interaction analysis. A sample of 45 secondary school students was selected through simple random sampling. The structured method emphasized breaking equations into clear steps, using visual aids, colour-coded atoms, and conservation-of-mass diagrams to help students understand atom rearrangement. Results showed that students taught through this approach exhibited higher accuracy, stronger conceptual understanding, and less confusion with coefficients and subscripts. They improved in identifying reactants and products and checking their work systematically. The study recommended integrating hands-on activities, digital animations, differentiated worksheets, and regular low-stress quizzes to reinforce learning. Overall, the structured method proved effective in enhancing students' confidence and ability to balance chemical equations.

Research Methodology

In the present study, **Quantitative research method with experimental research design** is used.

Sampling: The sample consists of 6 students studying in 9^{th} standard of Kamadhenu Convent, Basavanagudi, Hebbal of Mysore city which belongs to Hebbal Cluster of Mysuru North Block.

Research Tool:

Researcher developed Questionnaire for Pre-Test and Post-Test. Questionnaire consists of 20 objective type questions with the maximum marks of 1 each.

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

To substantiate the above phases, the researcher conducted the Pre-test to check the prior knowledge of the students on applying fundamental operations in real life. On this basis the researcher conducted 5 activities to eradicate the misconceptions and enhance the understanding and application level of the students 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
1	Story telling method	30 mins	1
2	Equation puzzle card	30 mins	1
3	Hand on atom model	20 mins	2
4	What's missing? Game	30 mins	1
5	Error detectives	30 mins	1

Description of Action Plan

Activity 1: Story telling

The storytelling method was an imaginative teaching approach used to help 9th-standard students overcome difficulties in balancing chemical equations. In this method, the teacher converted chemical reactions into simple, meaningful stories where atoms and molecules were treated as characters with specific roles. The equation was presented as a scene in which all characters had to appear in equal numbers on both sides to maintain fairness and balance. Through narration, gestures, drawings, and sometimes role-play, students visualized how reactants changed into products without losing or gaining atoms. This helped them naturally understand the law of conservation of mass. The teacher encouraged students to predict the next part of the story, identify imbalances, and suggest how the "characters" could be arranged correctly using coefficients. By transforming abstract symbols into relatable situations, the storytelling method reduced confusion, increased interest, and built confidence. It made the process of balancing equations enjoyable, memorable, and easier for all learners.

Activity 2: Equation Puzzle Card

Equation Puzzle Cards were a hands-on, activity-based teaching tool designed to help students understand and practice balancing chemical equations in an enjoyable way. Each puzzle card set contained two types of cards: reactant cards and product cards, with symbols or formulas of different elements and compounds. Students were asked to match and arrange these cards so that the number of atoms on the reactant side equaled the number of atoms on the product side. By physically manipulating the cards, learners visualized how coefficients helped achieve balance. This method promoted active learning, improved problem-solving skills, and made balancing equations more interactive and engaging for 9^{th} standard students.

Activity 3: Hand on atom model

The Hands-on Atom Model was an effective, activity-based method used to help 9th-standard students understand and overcome difficulties in balancing chemical equations. In this approach, students used simple physical materials such as colored beads, buttons, clay balls, or paper circles to represent different types of atoms. These atoms were then grouped to form molecules on both the reactant and product sides of a chemical equation. By arranging and rearranging these pieces, students could clearly see how many atoms of each element were present and where imbalances occurred. This visual and tactile method helped students understand that atoms could not be created or destroyed, reinforcing the law of conservation of mass. When students added or adjusted coefficients to balance the atoms, they observed the process in a concrete and meaningful way. The hands-on model promoted active participation, encouraged collaborative learning, built problem-solving skills, and made the abstract concept of balancing equations more enjoyable, logical, and easy to grasp.

Activity 4: What's missing? - Game

The "What's Missing?" game was an interactive classroom strategy used to help 9th-standard students understand and practice balancing chemical equations in an enjoyable way. In this activity, the teacher presented an unbalanced chemical equation but intentionally left out some atoms or coefficients on either the reactant or product side. Students had to carefully observe the equation, identify what was missing, and supply the correct number of atoms or coefficients to make both sides equal. This game encouraged students to think critically, compare atom counts, and apply the law of conservation of mass in a playful manner.

Activity 5: Error detective

The "Error Detective" activity was an engaging classroom strategy designed to help 9th-standard students identify and correct mistakes in balancing chemical equations. In this method, the teacher gave students chemical equations that were intentionally balanced incorrectly, containing errors such as wrong coefficients, unequal atom counts, or misplaced formulas. Students took on the role of "detectives" and carefully examined each equation to find where the mistake occurred. They compared atoms on both sides, analyzed which element was unbalanced, and rewrote the equation correctly. This approach encouraged critical thinking, observation, and logical reasoning.

Working individually and in groups, students enjoyed the challenge of spotting errors, discussing possible corrections, and justifying their answers. The activity helped them understand common mistakes made while balancing equations and taught them how to avoid these errors. By transforming the learning process into a detective-style investigation, the method reduced fear, increased motivation, and improved mastery of balancing chemical equations in a fun and interactive way.

Data Analysis

Table 2: Statement of Students Performance

Sl. No.	Name of the Students	Scores		Difference	% of improvements
		Pre -Test	Post-Test		
1	Sample 1	02	12	10	50
2	Sample 2	02	13	11	55
3	Sample 3	04	11	07	35
4	Sample 4	03	15	12	60
5	Sample 5	04	16	12	60
6	Sample 6	03	15	12	60

Graphical Representation

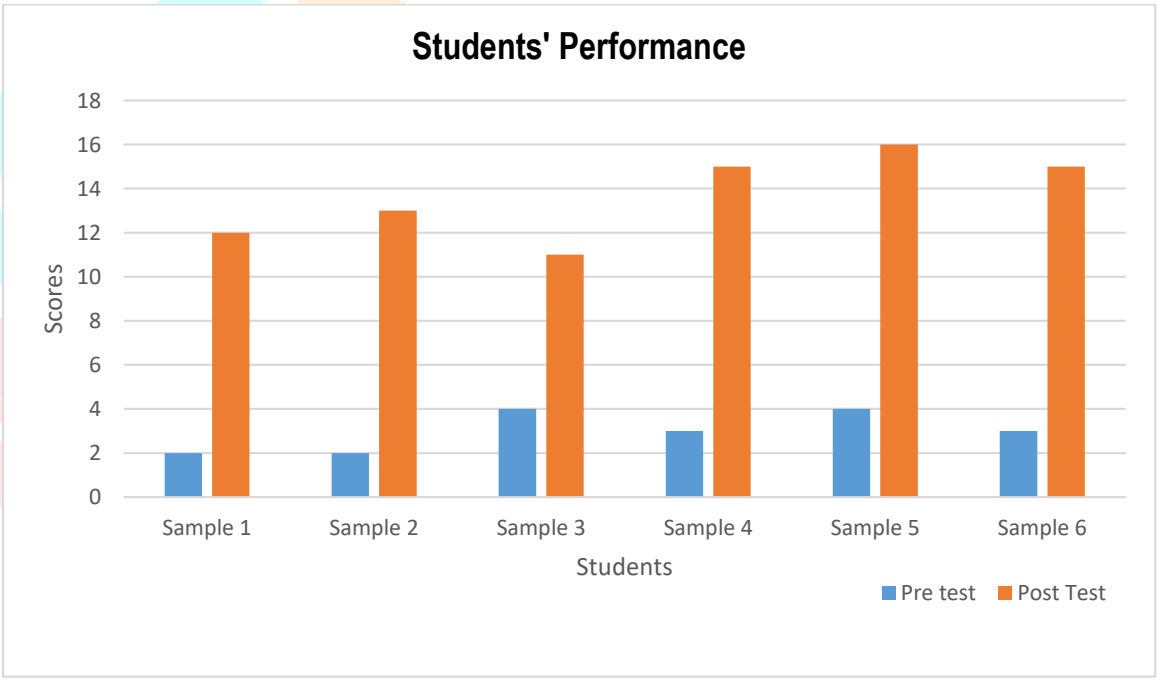

Figure- 5: Graph showing the effectiveness of the action plan

Interpretation

The analysis of test results revealed that the average **pre-test** score of the learners was **6.0**, showing that students initially struggled to apply correct step in balancing chemical equation. After the implementation of the intervention, there was a notable rise in the average **post-test** score to **13.66**, indicating a clear improvement in understanding and application. The comparison between pre-test and post-test results suggests that the teaching strategies adopted were effective in strengthening conceptual clarity and overall performance in balancing chemical equation.

Findings of the Study

1. Students faced difficulty in recognizing balanced and unbalanced chemical equations.
2. After the action plan, students were able to recognize and balance the chemical equations.
3. Through story telling method, students were able to relate to the elements and compounds and tried to balance the equations.
4. The hands-on atom model activity revealed that students grasp atomic structure better through concrete, manipulative methods.
5. The equation puzzle card and What's missing? activities revealed that students balanced equations more accurately and confidently when learning was interactive and game-based.
6. The error detective activity revealed that students learned equations more accurately when they investigated and corrected errors themselves, showing that detective-style methods reduce misconceptions and strengthen understanding.
7. Overall, the students showed noticeable improvement in balancing the equations.

Suggestions

1. Teacher should use step-by-step method rather than only lecture-based teaching in teaching of balancing chemical equation.
2. Provide regular practice worksheets with increasing difficulty level of balancing equation to improve their balancing skill.
3. Use visual aids, color codes and activity-based learning to simplify abstract concepts for the slow learners.
4. Conduct short quizzes about the skill of balance equation to reinforce learning.
5. Encourage peer learning for slow learners.
6. Reinforce the law of conservation of mass before teaching balancing.

Conclusion

Balancing chemical equation is often challenging for 9^{th} standard students due to abstract concepts. Limited mathematical skills, and a lack of proper visualization of atoms and molecule, these difficulties can create confusion and reduce interest in learning chemistry. However, with the use of innovative teaching method, such as hands on activities, equation puzzle, error detective activities and guided practice, students can gradually overcome- these challenge, strengthening their logical thinking applying step-by step strategies and using real life examples can make the process easier and more engaging. Therefore, effective teaching approaches and consistent practice are essential for helping students master the skill of balancing chemical equation.

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