Enhancing 9th Grade Students' Understanding of the Periodic Table through Activity-Based Remedial Instruction: An Action Research Study

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***Abstract*—Understanding the periodic table is a foundational requirement in school chemistry; however, many secondary school learners struggle due to abstract concepts, symbolic representation, and difficulty understanding periodic trends. The present action research investigated learning difficulties among Grade 9 students and evaluated the effectiveness of activity-based remedial instruction in improving conceptual understanding of the periodic table.**

A pre-test was administered to 40 students, from which 16 low achievers scoring below 10 marks (out of 25) were purposively selected for intervention. A 40-day remedial program involving models, charts, collaborative activities, mnemonic strategies, and digital visualizations was implemented. Post-intervention achievement was measured using a structured post-test.

Descriptive and inferential analyses indicated substantial improvement in student performance. Mean achievement increased from 6.25 in the pre-test to 17.81 in the post-test. A paired-sample t-test demonstrated statistically significant gains ($p < 0.001$). Effect size analysis showed strong intervention impact. Findings indicate that structured remedial and activity-centered instruction significantly improves students' conceptual understanding and retention related to the periodic table.

***Keywords*— Periodic Table, Action Research, Activity-Based Learning, Chemistry Education, Remedial Instruction, Secondary Students.**

I. INTRODUCTION

Science education aims not only at acquisition of facts but also development of conceptual understanding. Chemistry, in particular, requires students to move between observable phenomena and abstract symbolic representations. Among the foundational concepts in chemistry, the periodic table serves as a conceptual framework for organizing matter and understanding chemical properties.

Despite its importance, the periodic table is often perceived as difficult by school students because of:

- Memorization of numerous element symbols and names
- Understanding periodicity and trends
- Relating atomic number to arrangement
- Conceptualizing groups, periods, and valency
- Abstract nature of atomic structure

Traditional lecture-dominated approaches frequently emphasize rote memorization rather than conceptual learning, leading to misconceptions and low achievement.

Action research provides teachers an effective process for identifying classroom problems, implementing interventions, and improving practice systematically. The present study uses action research to address difficulties in learning the periodic table among Grade 9 students.

II. REVIEW OF RELATED LITERATURE

Previous studies indicate persistent student difficulties in learning chemical symbolism and periodic relationships.

Anders (1966) emphasized action research as a classroom-centered approach to solving instructional problems. Bellanca and Fogarty (2003) highlighted cooperative and activity-based approaches for deeper conceptual learning.

Research in chemistry education suggests:

- Visual models improve understanding of atomic structure.
- Activity-based methods increase engagement and retention.
- Remedial instruction can reduce misconceptions.
- Multiple intelligence strategies support symbolic learning.

However, limited classroom-based action research has focused specifically on difficulties in learning the periodic table at secondary level.
This study addresses that gap.

III. STATEMENT OF THE PROBLEM

Students of 9th Standard Having Problems in Understanding and Learning the Periodic Table

IV. OBJECTIVES OF THE STUDY

The study aimed:

1. To identify concepts in the periodic table difficult for Grade 9 students.
2. To examine reasons behind students' learning difficulties.
3. To assess effectiveness of activity-based remedial teaching.
4. To compare achievement before and after intervention.
5. To improve conceptual understanding through learner-centered strategies.

V. RESEARCH HYPOTHESIS

H0: There is no significant difference between pre-test and post-test scores of students after remedial intervention.
H1: There is significant difference between pre-test and post-test scores after remedial intervention.

VI. METHODOLOGY

6.1 Research Design
The study adopted:

- Action Research Design
- One Group Pre-Test Post-Test Design

Design representation:
O1 → X → O2
Where:
O1 = Pre-test
X = Remedial Intervention
O2 = Post-test
6.2 Sample
Population: 40 Grade 9 students.
Sample: 16 students scoring below 10 marks selected purposively.
6.3 Intervention (40 Days)
Strategies implemented:

- Periodic table models
- Flash cards and symbol games
- Group activities
- Mnemonic techniques
- Concept mapping
- Digital periodic table tools
- Practice worksheets
- Feedback sessions
- Peer discussion
- Guided remedial teaching

6.4 Tool Used
Achievement Test on:

- Element symbols
- Atomic numbers
- Groups and periods
- Periodic trends
- Valency and reactivity

Maximum Marks: 25

VII. DATA ANALYSIS AND RESULTS

Table 1 Descriptive Statistics

Statistic	Pre-Test	Post-Test
Mean	6.25	17.81
Median	6.33	17.50
Mode	6.49	16.88
Standard Deviation	2.90	4.49
Quartile Deviation	2.67	3.62

VIII. INFERENTIAL STATISTICS

Paired Sample t-Test
Using student scores:
Mean Gain = 11.56
Calculated t-value ≈ 9.84
Degrees of freedom = 15
Critical t (0.05) = 2.13
Since:
9.84 > 2.13
Reject H0.
There is statistically significant improvement.
$p < 0.001$
Effect Size (Cohen's d)
Estimated Cohen's d = 2.5+
Interpretation: Very Large Educational Effect.

IX. FINDINGS

The study found:

1. Students had conceptual difficulty understanding arrangement of elements.
2. Memorization of symbols and atomic numbers was a major obstacle.

3. Students showed higher engagement with visual and activity-based learning.
4. Remedial intervention significantly improved understanding.
5. Student achievement increased considerably after 40-day intervention.
6. Activity-based instruction reduced misconceptions and increased retention.

X. DISCUSSION

The findings support constructivist views that students learn abstract concepts more effectively through active engagement than passive reception.
Improvement in achievement aligns with earlier findings by Bellanca and Fogarty (2003) regarding cooperative learning and by Lazear (1999) regarding multiple intelligence approaches.
The significant post-test gains indicate that remedial intervention transformed learning from rote memorization toward conceptual understanding.
This demonstrates the pedagogical value of learner-centered chemistry instruction.

XI. EDUCATIONAL IMPLICATIONS

The study suggests:

- Periodic table teaching should incorporate activity methods.
- Remedial instruction should be part of regular classroom practice.
- Digital tools can simplify abstract chemistry concepts.
- Teachers should shift from memorization-driven instruction to conceptual pedagogy.

XII. CONCLUSION

The study concludes that difficulties in learning the periodic table can be effectively addressed through structured remedial teaching using activity-based and visual strategies.
Traditional approaches alone are insufficient for meaningful conceptual learning.
Action research-based classroom interventions can significantly improve achievement, engagement, and conceptual understanding in chemistry.
Thus, learner-centered remedial pedagogy is recommended for teaching foundational chemistry concepts at secondary level.

XIII. LIMITATIONS OF THE STUDY

- Small sample size (16 students)
- Limited to one school
- Focused only on periodic table concepts
- Short intervention duration

XIV. SUGGESTIONS FOR FURTHER RESEARCH

Future studies may examine:

- Digital periodic table simulations
- Larger experimental studies
- Comparative teaching methods
- Long-term retention studies
- Application to other chemistry concepts

XV. ETHICAL STATEMENT

Permission was obtained from school authorities prior to conducting the study. Student participation was voluntary and data were used solely for educational research purposes.

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