



Active Learning Strategies To Improve Understanding Of Atoms And Molecules Among 8th Standard Students

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ABSTRACT

This action research study investigated the effectiveness of active learning strategies in enhancing the conceptual understanding of atoms and molecules among 8th standard students. The study addressed the persistent challenge of teaching these abstract concepts, which are often difficult for students to visualize and comprehend through traditional lecture methods. A one-group pre-test post-test design was employed with a sample of 20 students from Government High School, Hinkal, Mysuru. Active learning strategies—including group activities and role play, 3D molecular model construction, animated simulations, and concept mapping were implemented over a period of four weeks. Pre-test results revealed low conceptual clarity with a mean score of 6.72, indicating significant learning gaps. Post-intervention results demonstrated substantial improvement, with the mean score increasing to 14.4. Students displayed enhanced visualization of atomic structures, active participation, and improved retention of scientific concepts. The study concludes that active learning strategies are effective in addressing misconceptions, improving comprehension of abstract concepts, and fostering student engagement in science learning. These findings underscore the importance of integrating interactive, student-centered teaching methods into science classrooms to improve conceptual understanding and learning outcomes.

Keywords: Active Learning Strategies, Atoms and Molecules, Role Play, 3D Models, Animated Simulations, Concept Mapping, Student Engagement.

INTRODUCTION

Understanding the structure of matter is a cornerstone of science education. Concepts such as atoms and molecules form the basis for explaining physical and chemical changes, biological processes, and the composition of materials in our daily lives. However, for many secondary school students, these ideas remain abstract and difficult to grasp. This challenge arises primarily because atoms and molecules are invisible to

the naked eye and require students to form mental models based on symbolic representations and theoretical principles.

This action research project is designed to investigate how such strategies can be effectively implemented in a secondary school setting to improve students' conceptual understanding of atoms and molecules, reduce common misconceptions, and enhance overall science engagement.

NEED AND IMPORTANCE OF THE STUDY

Active learning strategies are essential for improving 8th standard students' understanding of atoms and molecules, as the topic is abstract and invisible to the naked eye. Traditional lectures often fail to build conceptual clarity. Approaches like group discussions, experiments, role play, concept mapping, and model-making engage students actively, making learning meaningful, concrete, and student-centered.

STATEMENT OF THE PROBLEM:

Despite being fundamental to the study of science, the concepts of atoms and molecules are consistently reported as some of the most difficult topics for secondary school students to understand. These concepts are abstract, requiring students to visualize structures and processes that cannot be seen directly.

CAUSES OF THE PROBLEM

- 1. Abstract Nature of the Concept:** Atoms and molecules are invisible to the naked eye, making it difficult for students to visualize and relate them to real-world experiences.
- 2. Overreliance on Textbooks and Lectures:** Traditional teaching methods often focus on memorization and theoretical explanations, with little opportunity for active exploration or hands-on learning.
- 3. Lack of Visual and Physical Models:** Without concrete models or simulations, students struggle to form mental representations of atomic structure and molecular interactions.
- 4. Limited Prior Knowledge:** Many students lack foundational scientific understanding, which makes it harder to grasp more complex or symbolic concepts like electron configurations and bonding.
- 5. Misconceptions from Everyday Language:** Common language use (e.g., “splitting atoms”) can reinforce inaccurate mental models.
- 6. Insufficient Classroom Time:** Time constraints often prevent teachers from engaging students in deeper discussions, experiments, or conceptual reinforcement activities.
- 7. Difficulty Understanding Scientific Symbols and Notations:** Students often find chemical formulas, element symbols, and diagrams confusing without proper explanation or contextual support.
- 8. Lack of Differentiated Instruction:** Uniform teaching approaches may not meet the diverse learning needs and styles of all students, leading to confusion or disengagement.

PRIORITIZED CAUSES

1. Abstract Nature of the Concept.
2. Misconceptions from Everyday Language.
3. Difficulty Understanding Scientific Symbols and Notations.
4. Lack of Visual and Physical Models.
5. Limited Prior Knowledge.

OBJECTIVES OF THE STUDY

1. To identify the difficulties faced by the students in understanding the concepts of atoms and molecules.
2. To assess the extent of misconceptions related to atomic and molecular structure among students.
3. To implement teaching strategies such as physical models, simulations, and group activities to address these difficulties.
4. To evaluate the effectiveness of these strategies in improving students' conceptual understanding.
5. To enhance student engagement and interest in learning abstract scientific concepts.
6. To promote the use of student-centered teaching approaches in science classrooms.

REVIEW OF RELATED LITERATURE

Fitriza, Z., & Gazali, F. (2017), in their study *Diagnosing Students' Conception on Atomic Structure Using Open-Ended Questions*, Fitriza and Gazali aimed to identify students' understanding of atomic structure concepts. A test with seven open-ended questions was given to 135 senior high school students from different schools in West Sumatera. The results showed that students struggled with key concepts such as atoms, atomic models, electron configuration, and periodic classification. The findings suggest that teaching approaches should pay more attention to these difficult areas in order to improve conceptual understanding.

Kiray, S. A. (2012), in the study *The Pre-service Science Teachers' Mental Models for Concept of Atoms and Learning Difficulties*, Kiray examined the atomic conceptions of 142 preservice science teachers using the Draw an Atom Test (DAAT) and interviews. Eight categories of atomic models were identified, with the Bohr model being the most common among students. The study revealed that preservice teachers had significant difficulties in understanding concepts such as electron clouds, orbitals, quantum probability, and wave-particle duality. This indicates the need for more effective instructional strategies in teaching atomic theory.

MacKinnon, G. R. (2009), study *Students' Understanding of Orbitals: A Survey* focused on the difficulties students face with the abstract concept of orbitals. A pilot study with 20 teacher trainees and a survey of 302 students were conducted to explore how learners explain orbitals. Three communication styles emerged: written descriptions, symbolic representations, and pictorial models. The findings indicated that many students struggled with symbolic conventions of electron configuration. The study recommended the use of appropriate models to help learners better understand orbitals.

Liendo, G. (2002), conducted a study titled *Arguments, Contradictions, Resistances, and Conceptual Change in Students' Understanding of Atomic Structure*. The research involved 160 first-year university students in general chemistry courses. The study compared traditional instruction with a discussion-based approach where students argued for and against different scientific models (Thomson, Rutherford, and Bohr). The findings showed that discussions based on arguments and counterarguments led to deeper understanding and conceptual change. Students in the experimental group performed better than those taught only through traditional methods, highlighting the importance of teaching science through heuristic principles rather than just experimental facts.

RESEARCH METHODOLOGY

The present study employed a **quantitative method with an experimental research design**. Specifically, a **one-group pre-test post-test design** was adopted to assess the effectiveness of the intervention in improving students' conceptual understanding of atoms and molecules.

Research Design: The design followed a pre-test–intervention–post-test model. During the intervention phase, instructional strategies such as visualization using models and diagrams, analogies, ICT-based simulations, group discussions, and creative activities were implemented over a period of four weeks.

Research Tool: Researcher developed questionnaire was used as the tool for data collection. The questionnaire consisted of both objective and descriptive questions and carried a total of 20 marks. It was administered before and after the intervention to measure changes in students' conceptual understanding.

Population: The population of the study comprised 45 students of Class VIII from Government High School, Hinkal, Mysuru which belongs to Hinkal Hundi Cluster, Mysuru Rural Block of Mysuru District.

Sampling: The study used purposive sampling to identify students who experienced difficulties in understanding abstract concepts in science. The sample consists of 20 students from Class VIII of the same school.

PROCEDURE

1. Planning Phase

- Identified learning difficulties from past assessments via pre-test questionnaire.
- Developed a lesson plan and incorporated selected strategies.
- Prepared necessary materials (models, visuals, digital tools, etc.)

2. Pre-Test Administration

- Conducted a short assessment to determine students' initial understanding of atoms and molecules.

3. Implementation Phase (Intervention)

- Delivered 4–6 lessons over two weeks using the chosen strategies.
- Each session focused on a sub-topic (e.g., atomic structure, molecule formation, bonding types).
- Used a variety of strategies in each lesson to cater to different learning styles.

4. Post-Test Administration

Conducted a similar test to the pre-test to measure learning gains.

5. Data Collection and Reflection

- Comparison of pre- and post-test results.
- Analyse feedback forms and observation notes.
- Reflect on which strategies were most effective.

ACTION PLAN

Table-1: Details of Action Plans

Sl. No.	Activity Name	Duration	Days
1	Group Activities and Role Play	40 min	1
2	3D Molecular Models	40 min	1
3	Animated Simulation	40 min	2
4	Concept Mapping	40 min	1

DESCRIPTION OF THE ACTION PLAN

1. Group Activities and Role-play

Students were divided into small groups and assigned roles representing different atoms. They acted out the process of forming molecules, such as H_2O and CO_2 , by “bonding” with other students according to atomic rules. This interactive method helped students visualize abstract concepts and understand how atoms combine to form molecules in an engaging way.

2. 3D Molecular Models:

Students constructed molecules using 3D model kits or clay balls. They physically connected “atoms” to create various molecular structures, observing the shape and arrangement of atoms. This hands-on activity reinforced spatial understanding and made molecular formation tangible.

3. Animated Simulations:

Students constructed molecules using 3D model kits or clay balls. They physically connected “atoms” to create various molecular structures, observing the shape and arrangement of atoms. This hands-on activity reinforced spatial understanding and made molecular formation tangible.

4. Concept Mapping

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DATA ANALYSIS

Table 2: Statement of Students Performance

Sl. No.	Name of the Students	Scores		Difference	Percent of improvements
		Pre -Test	Post-Test		
1	A	6	14	8	32
2	B	6	17	11	44
3	C	6	15	9	36
4	D	4	16	12	48
5	E	6	16	10	40
6	F	3	16	13	52

Sl. No.	Name of the Students	Scores		Difference	Percent of improvements
		Pre -Test	Post-Test		
7	G	11	17	6	24
8	H	6	12	6	24
9	I	10	15	5	20
10	J	6	17	11	44
11	K	6	15	9	36
12	L	7	17	10	40
13	M	9	13	4	16
14	N	6	13	7	28
15	O	4	17	13	52
16	P	5	9	4	16
17	Q	7	15	8	32
18	R	7	8	1	4
19	S	6	13	7	28
20	T	7	17	10	40

Pre-Test Statistical Analysis:

Table 3: Frequency Distribution Table of Pre-Test Score

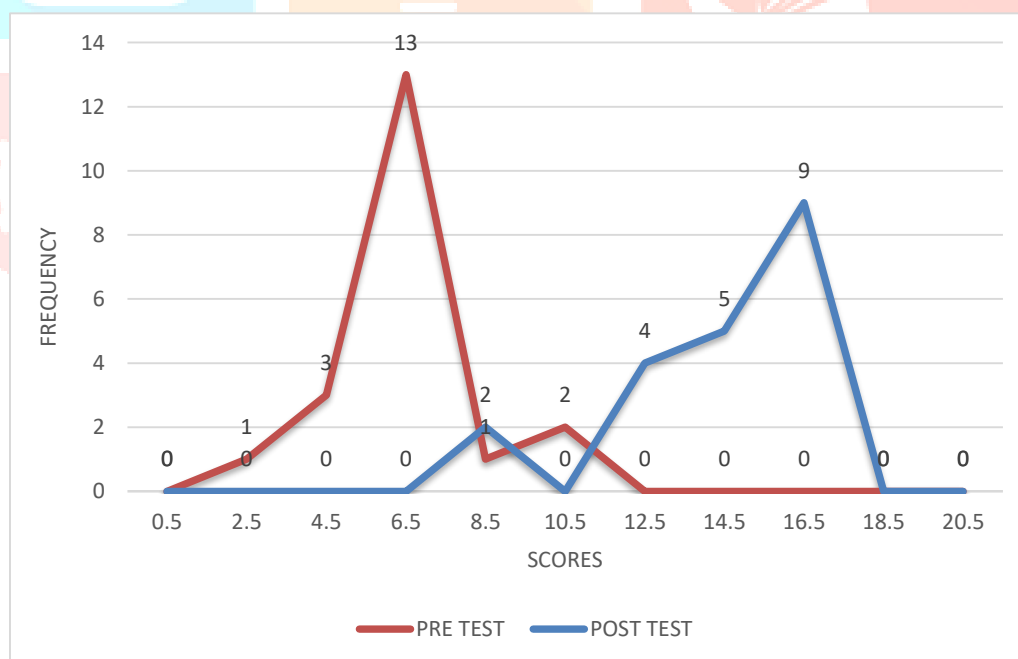
Class Interval	Frequency(f)	Midpoint(x)	fx	Cumulative frequency
00-01	0	0.5	0	0
02-03	1	2.5	2.5	1
04-05	3	4.5	13.5	4
06-07	13	6.5	84.5	17
08-09	1	8.5	8.5	18
10-11	2	10.5	21	20
12-13	0	12.5	0	20
14-15	0	14.5	0	20
16-17	0	16.5	0	20
18-19	0	18.5	0	20
20-21	0	20.5	0	20
	n=20		$\Sigma fx=134.5$	

Mean = 6.725, Median = 5.96, Mode = 4.43

Post-Test Statistical Analysis:**Table 4: Frequency Distribution Table of Post-Test Score**

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	2	8.5	17	2
10-11	0	10.5	0	2
12-13	4	12.5	50	6
14-15	5	14.5	72.5	20
16-17	9	16.5	148.5	20
18-19	0	18.5	0	20
20-21	0	20.5	0	20
	n=20		$\sum fx=288$	

Central Tendency: Mean = 14.4, Median = 15.39, Mode = 17.37

GRAPHICAL REPRESENTATION**Figure-1: Graph showing the performance of the students in Pre-Test and Post-Test****INTERPRETATION OF RESULT**

For the study, data were collected from 20 students of Class VIII. A pre-test and post-test consisting of 20 objective and short-answer questions were administered to assess the student's understanding of abstract concepts related to atoms and molecules. In the pre-test, the majority of students scored below the average mark, indicating limited understanding of the concepts. After implementing the activity-based strategies (use

of models, role play, group discussions and simulation), the post-test was conducted. The scores showed noticeable improvement, with a larger proportion of students achieving above-average marks.

By analyzing the data, the average score of the learners in the pre-test is **6.72**. After the action plans the learners are improved in the learning process and got **14.4** as the average score in post-test. The results support the assumption that activity-based methods are effective in enhancing comprehension of abstract science concepts.

RESEARCH FINDINGS

1. Pre-test results showed that only 30% of students understood the concepts of atoms and molecules.
2. After the intervention, post-test results revealed a 40% improvement in scores.
3. Students demonstrated clearer visualization of atomic structures and molecular formation.
4. Participation increased, with 85% of students actively engaging in discussions and activities.
5. Feedback indicated that models and animations were the most effective strategies for comprehension.

SUGGESTIONS

1. Teachers should use models, simulations, and analogies regularly while teaching abstract topics.
2. ICT-based learning resources should be integrated into science teaching.
3. Group activities and peer learning should be encouraged to make learning interactive.
4. Further action research should be carried out for other abstract concepts in science.

CONCLUSION

The action research concluded that students' understanding of atoms and molecules improved considerably when abstract concepts were made concrete through multiple strategies. The pre-test and post-test results showed clear academic progress, while classroom observations indicated increased curiosity, participation, and confidence among students. The use of models and analogies reduced misconceptions, ICT tools created visual impact, and collaborative activities promoted peer learning. The research also proved that traditional lecture-based teaching alone was not sufficient to clarify such abstract ideas. By integrating innovative strategies, the teaching-learning process became more engaging and effective. This study further concluded that sustained use of these methods could strengthen conceptual clarity, improve retention, and develop a positive attitude toward science.

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