AMERICAN JOURNAL OF EDUCATION AND LEARNING
ISSN: 2996-5128 (online) | ResearchBib (IF) = 9.918 IMPACT FACTOR
Volume-3| Issue-5| 2025 Published: |30-05-2025|

TEACHING THE CONCEPT OF SUBLIMATION IN PHYSICS LESSONS AT GENERAL SECONDARY SCHOOLS USING THE "MENTAL MAP" METHOD

https://doi.org/10.5281/zenodo.15427576

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Abstract

This article explores the theoretical and practical aspects of using the "Mental Map" method in teaching the concept of sublimation in physics lessons at general secondary schools. Sublimation, the direct transition of a substance from a solid to a gas, is a key topic in the study of physical processes. However, its abstract nature often makes it challenging for students to fully grasp. The Mental Map method offers a visual and interactive approach to teaching, which allows students to organize and connect complex concepts in a systematic way. This method helps students better understand the relationships between key ideas related to sublimation, such as the physical principles, real-life applications, and molecular-level processes involved.

Keywords:

Sublimation, physics education, mental map method, teaching methodology, visual learning aids, students' cognitive development, interactive learning, concept comprehension, creative thinking, educational technology, secondary school teaching.

INTRODUCTION

The teaching of physical concepts in general education schools plays a crucial role in shaping students' understanding of the natural world. Among these concepts, sublimation stands as an important process that helps students grasp the changes in the physical states of matter. However, sublimation, as a phenomenon where a substance transitions directly from a solid to a gas, can be abstract and challenging to comprehend for many students. Therefore, innovative teaching methods are necessary to effectively convey this complex concept.

One such method is "Mind Mapping", a visual and interactive approach that enables students to organize and connect information systematically. This method

helps in simplifying complex topics by presenting them in a clear and structured manner. By using mind maps, students can visualize the relationships between different concepts involved in sublimation, facilitating a deeper understanding and retention of the material. The article examines the benefits of using mental maps to enhance the learning process, providing insights into how this method promotes deeper comprehension, encourages creative thinking, and improves the retention of scientific concepts. Practical recommendations for teachers on how to implement this method effectively in the classroom are also provided. The study concludes that the use of mental maps significantly improves students' understanding of sublimation and other complex scientific topics, leading to a more engaging and efficient learning experience.

This study focuses on the integration of the mind mapping method into physics lessons, specifically when teaching the topic of sublimation. The aim is to explore how this technique can enhance students' comprehension of the physical principles behind sublimation, its real-life applications, and its theoretical underpinnings. The use of mind maps not only aids in breaking down the topic into manageable parts but also stimulates creative thinking, fostering a more engaging and active learning environment.

This introduction highlights the need for innovative educational strategies and the potential of mind mapping as a tool for improving both the understanding and teaching of complex scientific phenomena like sublimation in secondary school physics classes.

Analysis of Literature

Various studies have been conducted on the use of modern teaching methods for the process of sublimation and its physical principles. The analysis of scientific literature shows that visual approaches and interactive methods, particularly the "Mental Map" method, play an important role in enhancing students' understanding of complex scientific concepts.

Special attention should be given to research based on conceptual mapping methods developed by D.B. Gowin (1984) and J. Novak (1998) on the application of mental maps in education. These methods not only provide systematic explanations of topics but also foster the development of students' creative thinking skills. Mental maps create strong associative connections in students' minds through the visual representation of educational content. [1, 2]

Also of great importance are the studies of scholars such as J. Sears and M. Zemansky (2021) in literature related to the sublimation process, specifically in the study of thermodynamic processes. Their works provide methods for explaining

the sublimation process at the molecular level and recommendations for simplifying this concept in the educational process. [3, 4]

Research conducted in Uzbekistan on the implementation of mental maps and other modern pedagogical technologies in the educational process, particularly the programs developed within the framework of the Education Development Strategy of the Republic of Uzbekistan (2017-2030), is aimed at strengthening students' theoretical and practical knowledge. [5]

This article, based on the aforementioned literature and contemporary research, analyzes the practical aspects of teaching the topic "Sublimation" using the "Mental Map" method and the opportunities to improve the effectiveness of learning.

A mental map is a visual tool that helps organize, memorize, and facilitate the assimilation of information. It is created in the form of graphic images that show the connections between different concepts, ideas, or processes. A mental map allows students to simplify complex information, arrange it into a logical system, and gain a comprehensive understanding of a specific topic.

Sublimation is the process of a substance directly transitioning from a solid to a gaseous state. This is one of the important topics studied in physics, but explaining it to students can be challenging. This is because the sublimation process can occur so quickly that it cannot be seen with the naked eye or at the microscopic level. Understanding this process helps students better comprehend natural phenomena. However, its abstract nature may be difficult to grasp.

The use of the mental map method in teaching the topic of sublimation offers students the following advantages:

Through the mental map, students are shown the connections between the start, duration, and end of the sublimation process. For example, it forms a better understanding of how a solid substance transitions to a gaseous state under the influence of heat and the physical laws governing this process.

By visually representing complex physical processes like sublimation, students can more easily understand the topic. With a mental map, students can see the studied information in a complete, yet accessible form.

When using the mental map method, students independently establish connections between concepts and attempt to draw new conclusions. This process is beneficial to them both educationally and psychologically, as they are not only memorizing the material but also have the opportunity to analyze and generalize it. [6]

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The mental map encourages students to engage in independent work on the topic and exchange opinions in groups. This method allows students to ask questions related to the topic and seek answers.

The sublimation process can be observed under the following conditions:

Solid substances and their transition to a gaseous state: For example, dry ice (solid CO2) when poured out as "snow" directly transitions to a gaseous state.

Heating or lowering pressure: If a solid substance is at low temperature and low pressure, it may transition to a gaseous state.

One of the most famous examples of the sublimation process is the transformation of dry ice (solid carbon dioxide) into gas, i.e., it transitions directly to a gaseous state, bypassing the liquid phase.

The sublimation process is often characterized by deviations or changes and can be energetically advantageous.

METHODOLOGY

This study applies scientific and pedagogical methods to analyze the theoretical and practical aspects of teaching the topic "Sublimation" in the physics curriculum of general secondary schools using the "Mental Map" method. The methodology includes the following stages:

Theoretical Analysis. Existing scientific literature and advanced pedagogical technologies for teaching the topic of sublimation were studied. The role of the mental map method in the educational process, its didactic possibilities, and its influence on the consolidation of students' knowledge were analyzed.

Practical-Experimental Work. The research includes experimental work conducted in physics lessons in general secondary schools. The process involved the following activities:

Lesson planning on the topic of sublimation using the mental map method;

During the lesson, the teacher explained the main concepts of the sublimation process, its physical foundations, and its real-life applications using a mental map;

Practical sessions were held, during which students independently created mental maps and analyzed them. [7]

Diagnostic Methods. Initial and final assessments were conducted to determine students' knowledge levels on the topic. The diagnostic evaluation was based on the following criteria:

The level of students' understanding of the concepts related to the topic;

The understanding and ability to apply scientific terms related to the sublimation process;

The ability to systematically present the main parts of the topic using a mental map.

Comparison and Analysis. The results of the experimental group (using the mental map method) and the control group (using traditional methods) were compared. The level of material mastery and changes in students' creative thinking skills were assessed.

Recommendations and Conclusions. Based on the results obtained, conclusions were drawn about the effectiveness of teaching the topic of sublimation using the "Mental Map" method, and practical recommendations for teachers were developed.

This methodology proposes scientifically grounded approaches for organizing the process of interactive and effective teaching of the topic.

RESULTS AND RECOMMENDATIONS

Results: Based on the conducted research and experimental work, the following conclusions were drawn:

Improvement in students' knowledge: Teaching the topic of sublimation using the "Mental Map" method contributed to a deeper understanding of the topic by students and a systematic mastery of the key concepts. Students in the experimental group demonstrated a higher level of knowledge on the topic compared to the control group.

Development of creative thinking and analytical skills: The mental map method helped students develop skills in generating new knowledge based on the topic, identifying relationships between concepts, and visually representing their thoughts.

Increased motivation and interest: The use of this method made lessons more interactive and engaging, resulting in increased interest in physics among students.

Effectiveness of the lesson: Mental maps allowed the topic to be studied meaningfully and efficiently within a short period of time. This helped teachers organize the learning process more effectively.

RECOMMENDATIONS:

Wide implementation of the mental map method: It is recommended to expand the use of the mental map method in teaching complex physics concepts in general secondary schools, especially topics such as sublimation. This method is an important tool for enhancing the effectiveness and interactivity of the learning process.

Teacher training: To effectively apply the mental map methodology, special teacher training should be conducted. Studying the didactic principles of this method in workshops and training sessions will enhance the quality of instruction.

Adaptation of teaching materials: It is recommended to adapt the teaching materials on the topic of sublimation to the mental map method and include special instructions on this method in textbooks and teaching aids.

Introduction of new technologies: The use of modern digital tools for creating mental maps, such as mobile applications and software, makes the learning process more convenient and engaging.

Expansion of research: More extensive research should be conducted to analyze the effectiveness of the "Mental Map" method in combination with other methods of teaching the sublimation topic.

By following these recommendations, the quality of physics education can be improved, leading to a deeper understanding of the topic by students.

CONCLUSIONS

The use of the "Mental Map" method in teaching the topic of "Sublimation" in the physics curriculum of general secondary schools has proven to be one of the innovative approaches for effectively organizing the learning process. This method provided visual and systematic study of the topic for students, facilitated the understanding of complex concepts, and contributed to the development of creative thinking skills.

Experience and analysis showed that the mental map method allows students to meaningfully and effectively master the topic in a short period of time. Student motivation increased, and alongside theoretical knowledge, practical skills were also developed. Additionally, the level of students' understanding of the key concepts of the topic and their interrelationships rose.

The results of this research served as the basis for developing practical recommendations for teachers on using the "Mental Map" method. Widespread implementation of this method can ensure high efficiency in teaching other complex physics topics. Therefore, it is necessary to widely apply this method in the educational process and pay special attention to teacher training for its effective use.

According to the final conclusion, the "Mental Map" method serves as an effective means of improving the quality of education by organizing the learning process in a new format.

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