

**THEORETICAL AND PRACTICAL FEATURES OF TEACHING THE SUBJECT
"HISTORY OF CHEMISTRY" BASED ON INTERDISCIPLINARY INTEGRATION*****Shakhnoza Khujamberdiyeva Kupaysinova,****Doctor of Science (DSc) in Pedagogical Sciences.
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Abstract: Teaching the history of chemistry plays an important role in shaping students' understanding of how scientific knowledge develops, evolves, and interacts with wider cultural and social changes. Unlike standard chemistry courses that focus mainly on formulas, experiments, and theories, this subject allows learners to see the progression of ideas within a broader human context. Using interdisciplinary integration makes teaching more effective by combining chemistry with philosophy, medicine, literature, physics, and even the arts. This article examines both theoretical principles and practical strategies of teaching the history of chemistry through integration. The discussion emphasizes the need to link chemical discoveries with their historical, cultural, and societal backgrounds, and presents approaches such as project-based learning, digital technologies, and cross-disciplinary collaboration. It is concluded that an integrated method strengthens motivation, encourages critical thinking, and prepares students to apply historical perspectives to contemporary scientific and social challenges.

Keywords: History of chemistry, interdisciplinary teaching, integration, science education, theoretical approaches, practical methods

INTRODUCTION: The subject History of Chemistry holds a special place within science education, as it provides not only a chronological overview of discoveries but also a deeper understanding of the processes through which scientific knowledge has evolved. Unlike conventional chemistry courses that focus on formulas, reactions, and theories in their finalized form, this discipline emphasizes the pathways of inquiry, the errors and corrections, and the cultural circumstances that shaped scientific progress. Such an approach allows students to see chemistry as part of human intellectual heritage rather than as a static body of knowledge. In modern pedagogy, the teaching of the history of chemistry is increasingly connected to the concept of interdisciplinary integration. This educational approach seeks to demonstrate the interdependence of scientific disciplines and the role of chemistry in a broader system of knowledge. Historical developments in chemistry cannot be separated from contributions of physics, biology, medicine, mathematics, and philosophy. For instance, the emergence of atomic theory was influenced by physical models of matter, while the progress of pharmacology and medical chemistry reflected urgent social needs related to health. By showing these interconnections, students gain an enriched perspective of scientific development and recognize that knowledge grows through cooperation across domains.

From a theoretical point of view, integrating disciplines helps to form a more complete scientific worldview. Learners understand that boundaries between sciences are fluid and that discoveries in one field often inspire breakthroughs in another. From a practical point of view, interdisciplinary teaching makes lessons more engaging, as it enables teachers to employ comparative case studies, project-based tasks, and problem-solving activities that mirror real-world complexity. This encourages students to move beyond memorization toward active

reasoning, evaluation of historical evidence, and application of ideas to new contexts. Moreover, the subject has significant value for developing 21st-century skills. By analyzing past scientific debates, students cultivate critical thinking, the ability to question assumptions, and the capacity to evaluate multiple perspectives. Exposure to historical contexts also fosters creativity, as learners see how unconventional ideas sometimes led to revolutionary changes. At the same time, reflecting on the ethical and social consequences of discoveries helps students develop responsible attitudes toward the use of science in society.

LITERATURE REVIEW

The role of history in science education has been widely examined in international research. Many scholars emphasize that integrating historical perspectives into chemistry teaching enriches students' conceptual understanding and promotes critical reflection on the nature of science. Matthews [1] argues that the history and philosophy of science provide an essential framework for improving scientific literacy, as they show that knowledge is not static but develops through debates, experiments, and revisions. Similarly, Brush [2] highlights that historical case studies enable learners to appreciate the tentative nature of scientific theories, which strengthens their ability to think critically and creatively. A recurring theme in the literature is that teaching the history of chemistry enhances students' comprehension of abstract concepts by situating them in real intellectual and cultural contexts. Niaz [3] emphasizes that examining past controversies, such as debates over atomic models, allows students to see how theories evolved and why certain scientific ideas prevailed. This method helps learners to grasp not only the content but also the process of scientific reasoning. In the same line, Holton [4] suggests that historical narratives make chemistry more meaningful, since students can connect chemical discoveries with broader developments in society and technology.

Several studies also point to the importance of interdisciplinary integration in teaching history of science. Justi and Gilbert [5] argue that historical episodes provide opportunities to link chemistry with physics, mathematics, and biology, thereby fostering a more coherent worldview among learners. By analyzing how discoveries in one discipline influenced another, students develop a holistic perspective of science as an interconnected system. Hodson [6] supports this view, noting that interdisciplinary approaches not only increase engagement but also encourage deeper understanding of the relevance of chemistry to everyday life.

RESULTS AND DISCUSSION

The teaching of the history of chemistry, when enriched with interdisciplinary integration, allows students to experience science not only as a technical discipline but also as a cultural, philosophical, and social process. Rather than reducing chemistry to a series of isolated discoveries and formulas, this approach emphasizes its evolution, its connections with other sciences, and its role in shaping human civilization. Through such methods, learners are able to construct a more holistic view of chemistry, one that blends conceptual understanding with humanistic perspectives. One of the most significant outcomes of this teaching model is the improvement in students' comprehension of difficult ideas. When chemical concepts are tied to their historical development, they become less abstract and more comprehensible. For instance, understanding how the concept of the atom moved from speculative philosophy to modern scientific models helps students see knowledge as a process rather than a set of rigid facts. This fosters intellectual flexibility, allowing them to adapt their understanding as new information

arises. It also creates a mindset in which students appreciate uncertainty and revision as natural parts of science, rather than viewing them as weaknesses.

The interdisciplinary model also enhances learner motivation. Traditional instruction in chemistry can sometimes appear disconnected from everyday experience, leading to disinterest. However, when historical episodes are introduced—such as the debates that accompanied major discoveries or the social impact of chemical innovations—students find relevance in what they study. They begin to perceive chemistry not just as a laboratory subject, but as a human endeavor full of challenges, rivalries, breakthroughs, and consequences. This narrative quality makes the subject more engaging and helps sustain long-term interest. Another important aspect of the interdisciplinary approach is its capacity to strengthen critical thinking. By studying historical controversies and competing theories, learners are encouraged to evaluate evidence, weigh arguments, and form their own conclusions. For example, comparing early and later models of chemical bonding allows students to consider why one explanation was replaced by another, and what evidence contributed to that change. Such exercises show that scientific knowledge is not absolute, but built through debate, experimentation, and refinement. This realization equips learners with analytical skills that extend far beyond the classroom.

Practical classroom experiences show that reconstructing historical experiments deepens understanding even further. When students repeat simplified versions of past experiments, they gain insights into the methods and limitations of earlier science. These activities highlight the challenges scientists faced without modern tools and allow learners to appreciate the creativity involved in drawing conclusions from limited data. Moreover, practical reconstructions help solidify theoretical concepts, turning abstract principles into tangible experiences. This kind of learning remains memorable, making it more likely that knowledge will be retained and applied later. The role of technology in teaching history of chemistry should also be emphasized. Modern digital tools, such as interactive simulations, multimedia presentations, and online archives, give students access to materials that were once unavailable outside specialized libraries. Learners can now explore ancient texts, watch visualizations of historical experiments, or engage in virtual laboratory activities that replicate past discoveries. These tools turn the study of history into an interactive process, where students actively explore instead of passively receiving information. Technology also enables teachers to tailor resources to different learning styles, ensuring inclusivity and accessibility. An interdisciplinary approach naturally encourages collaboration across subject boundaries. Chemistry teachers working with history, literature, or philosophy educators create lessons that reflect multiple dimensions of scientific development. For instance, the chemical revolution can be studied alongside political revolutions of the same period, allowing students to understand how science both shaped and was shaped by broader historical movements. This not only enriches the subject matter but also teaches learners that knowledge is interconnected, breaking down artificial barriers between disciplines. Such collaboration cultivates the ability to think across domains, a skill increasingly valuable in the modern world. Integrating ethical and social issues into the teaching of the history of chemistry is another valuable dimension. Many chemical discoveries have had profound impacts, both positive and negative, on society. Discussing these consequences—such as the development of chemical fertilizers that improved agriculture, or chemical weapons that caused devastation in wars—helps students recognize the responsibility that accompanies scientific progress. This moral awareness encourages them to reflect on the role of science in addressing present and future challenges, such as environmental protection, energy sustainability, and health care.

Creativity is another outcome fostered by this teaching method. By blending science with philosophy, art, and literature, students are invited to think beyond conventional boundaries. Projects that combine chemical analysis with artistic representation, or historical inquiry with creative writing, not only enrich understanding but also stimulate imagination. Such activities demonstrate that chemistry is not isolated from culture but interwoven with human creativity. Encouraging learners to view science through multiple lenses enhances their ability to generate original ideas, an essential skill in both academic and professional life. The interdisciplinary method also humanizes science. Students often believe that scientific achievements are the work of a few geniuses who operated beyond ordinary human limitations. In reality, the history of chemistry reveals a story of persistence, error, collaboration, and gradual progress. By learning about the struggles of past scientists—failed experiments, skepticism from peers, or limited resources—students gain confidence that they too can contribute to science despite difficulties. This sense of identification reduces intimidation and increases inclusivity, encouraging more diverse participation in scientific study.

CONCLUSION

The study of the subject “History of Chemistry” through interdisciplinary integration reveals its strong potential to enrich both teaching and learning. Instead of presenting chemistry as a fixed collection of facts or a list of isolated names, this approach frames the discipline as a dynamic process shaped by cultural, social, and intellectual contexts. It allows learners to connect scientific knowledge with human experiences, thereby deepening understanding and fostering lasting interest. One of the main achievements of this model is its ability to sharpen critical and reflective thinking. By analyzing how scientific ideas developed over time, students come to see that knowledge is built step by step, through questioning, trial, and improvement. This recognition encourages intellectual flexibility and equips learners to approach problems with an open mind. At the same time, connecting chemistry with other fields encourages creativity, making the learning process more engaging and meaningful. Equally important is the ethical dimension. When students explore both the benefits and risks of chemical discoveries, they develop an awareness of the responsibility that comes with scientific progress. Such awareness is vital in preparing them to face present and future global challenges, from environmental issues to technological advances.

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