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SEARCHING INTEGRATED STEM FRAMEWORKS IN CHEMISTRY

Abstract. This study explores the incorporation of STEM (Science, Technology, Engineering, and Mathematics) frameworks in Chemistry education through thorough analysis and evaluation. Utilizing established STEM frameworks as a basis, the research employs comparative analysis to assess their effectiveness within Chemistry. Through literature review and research analysis, the prevalence of integrated approaches, termed "Integrated Chemistry," is evident. Methods include identifying common themes, evaluating alignment with Chemistry curriculum standards, and exploring interdisciplinary

connections. The findings demonstrate the advantages of integrating STEM frameworks in Chemistry education, including enhanced interdisciplinary learning, improved critical thinking skills, and increased student engagement. This analysis emphasizes the importance of adopting integrated STEM approaches to enrich Chemistry education and prepare students for future endeavors. By examining the benefits and challenges, this abstract underscores the need for further research to enhance pedagogical practices and curriculum development in Chemistry education.

Keywords: STEM approach, High school chemistry, Integrative Chemistry

Introduction

In recent times, there has been a growing emphasis on the significance of offering students top-notch education in STEM subjects. Skilled professionals in these fields are essential for sustaining economic competitiveness globally and addressing contemporary needs like sustainable energy consumption, robust healthcare systems, and technology development with social and environmental considerations. [1] (*Boe et al., 2011*)

The primary focus of education for every student should be to attain proficiency in STEM literacy, encompassing comprehension of fundamental principles in science, technology, engineering, and mathematics, along with acquaintance with essential concepts from each discipline. [2] (*Bybee, 2010; National Academy of Engineering and National Research Council, 2014*).

One effective strategy in this context involves implementing an integrated STEM A successful approach in this scenario includes introducing a unified STEM curriculum, providing opportunities for students to participate in enhanced, coherent, and captivating learning opportunities. [3](*Furner and Kumar, 2007, p.186*).

Literature review

Integrated STEM Frameworks in Chemistry Education.

In the field of education, there has been a marked shift towards the integration of science, technology, engineering and mathematics (STEM) within various disciplines in order to provide students with a comprehensive learning experience. In the field of chemistry education, the study of integrated STEM systems has received significant attention, reflecting a broader commitment to developing interdisciplinary thinking and preparing students for the complex challenges of modern science. For example, tasks such as interdisciplinary pedagogy, influence on education, authentic problem-finding and problem-solving, solving social problems.

Integrated STEM systems facilitate the smooth integration of concepts from various disciplines, encouraging teachers to move beyond traditional subject boundaries. In chemistry education, this approach involves combining the principles of chemistry, physics, mathematics, and engineering to provide students with a holistic understanding of scientific phenomena. Using the interdisciplinary nature of STEM, teachers strive to develop important skills in students such as critical thinking, problem solving, and collaboration.

Scientific research on integrated STEM approaches in chemistry education has identified their potential to improve learning outcomes and student engagement. Scientific research has shown that students enrolled in integrated STEM curricula demonstrate a deeper conceptual understanding and increased motivation compared to their counterparts in traditional educational institutions. In addition, it

has been proven that the integrated STEM experience contributes to the development of a sense of relevance and applicability in real conditions, enriching the educational experience of students.

Central to integrated STEM systems is the promotion of authentic search and practical problem solving. Instead of passively receiving information, students are encouraged to actively explore scientific phenomena through experiments and project-based learning activities. By participating in authentic research, students develop a deeper understanding of the scientific process and acquire necessary skills such as hypothesis testing, data analysis, and experiment planning.

One of the key strengths of integrated STEM systems in chemistry education is their ability to solve complex social problems. By looking at chemistry in a broader social, environmental, and technological context, teachers can help students address real-world issues such as environmental sustainability, renewable energy, and healthcare. Through an interdisciplinary approach, students gain the knowledge and skills necessary to make a meaningful contribution to society and become informed citizens of the world.

Challenges and considerations: Despite the potential benefits, the introduction of integrated STEM systems into chemistry education is fraught with certain difficulties. Teachers should address issues such as teacher development, curriculum alignment, access to resources, and fair assessment strategies. In addition, efforts to promote diversity, equality and inclusivity through integrated STEM programs are necessary to ensure that all students have equal access to high-quality educational experiences. The integration of STEM disciplines in chemistry education represents a promising approach to enriching student learning experiences and preparing them for future scientific endeavors. By embracing integrated STEM frameworks, educators can foster interdisciplinary thinking, promote authentic inquiry, and empower students to address complex societal challenges. However, addressing the associated challenges and considerations is crucial to realizing the full potential of integrated STEM approaches and ensuring equitable access to quality education for all students.

The purpose of this study is to analyze existing integrated STEM approaches in chemistry education in order to identify the basic frameworks and principles that contribute to effective learning. "What kinds of frameworks are met in literature?" is identified as a research question.

Methodology

An extensive review of academic articles related to integrated approaches in chemistry education was conducted, with particular attention to aspects of integrated STEM structures. Working with keywords such as "Integrated Chemistry" and "Searching integrated STEM frameworks in Chemistry education" allowed us to identify relevant studies and articles for inclusion in the analysis. The study of the articles and their comparison made it possible to identify the key components and principles of integrated STEM approaches used in the context of chemistry education.

Sampling

Article name (author, year of publication)	Description
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Smith, J., & Johnson, A. (2020).	The article focuses on integrating STEM into chemistry education.
Garcia, M., & Martinez, R. (2019).	This literature delves into a case study in chemistry education, providing deeper insights into integrated STEM frameworks, aligning directly with the research objective.
Lee, C., & Kim, D. (2021).	This review highlights integrating engineering design into chemistry education, a vital part of STEM integration, broadening our understanding of STEM in chemistry.
Y., & Chen, L. (2018).	This literature explores math's role in integrated STEM in chemistry education, offering insights into interdisciplinary approaches.
Diana Laboy-Rush (2016)	This article explores how project-based learning in STEM motivates students with real-world challenges, emphasizing the role of teacher support.
Tamara J. Moore, Gillian H. Roehrig, and Tandra Tyler-Wood (2014)	This article explores STEM integration in middle schools, suggesting design-based curriculum planning to enhance it.
Frank Weinhold, Bradley W. Duerstock (2008)	Explores the relationship between chemistry and engineering in STEM.
Jody Bintz, Christine K. Nyberg, and Emily Thomas (2015)	The article explores integrating technology into education to enhance STEM learning in secondary schools.
Marcy H. Towns (2009)	The article aims to explore the current status of chemistry within the STEM movement and predict its future trajectory
Sarah J. Carrier, Susan B. Capobianco, and Gillian H. Roehrig (2007)	The article investigates how STEM integration impacts student learning and explores effective pedagogical strategies for teachers in middle school science

Data collection

During the research, I searched for articles in Google Scholar, related to integrated STEM frameworks in chemistry education, particularly focusing on the keyword "Integrated Chemistry". I explored various academic databases to find relevant literature and critically evaluated each article's suitability for addressing the research objectives. This process helped ensure that only pertinent and high-quality articles were included in the analysis, contributing to a comprehensive understanding of integrated STEM frameworks in chemistry education.

Data analysis

In analyzing the topic "Searching integrated STEM frameworks in Chemistry," I found that the keywords "Integrated chemistry" are widely used in literature and research. These frameworks aim to integrate chemical concepts with other STEM fields, improving understanding of interconnections among scientific disciplines. Further research could enhance our understanding of the advantages and limitations of such approaches in chemistry education.

Result

Article (Author, Year)	Frameworks and principles	Frequency	Percentage
1)"Incorporating Engineering Design in Chemistry Curriculum: A Literature Review" Lee, C., & Kim, D. (2021) 2) "Chemistry and engineering: a STEM synergy", Frank Weinhold and Bradley W. Duerstock (2008)	Engineering design	2	20%
1)Integrated STEM Education through Project-Based Learning, Diana Laboy-Rush (2016) 2) "STEM Integration in Middle School: A Design-Based Approach to Supports and Constraints" (2014)	Project-based	2	20%
"STEM integration in middle school science: student learning and teacher pedagogical strategies", Sarah J. Carrier, Susan B. Capobianco, and Gillian H. Roehrig (2007)	3D printing	1	10%

"The Role of Chemistry in the STEM Movement: Where We Are and Where We Are Going", Marcy H. Towns (2009)	PBL (Problem-based Learning)	1	10%
1) "Integrating STEM Concepts into Chemistry Education: A Comprehensive Review." Smith, J., & Johnson, A. (2020) 2) "Exploring Integrated STEM Frameworks: A Case Study in Chemistry Education." Garcia, M., & Martinez, R. (2019). 3) "The Role of Chemistry in the STEM Movement: Where We Are and Where We Are Going", Marcy H. Towns (2009) 4) "Chemistry and engineering: a STEM synergy", Frank Weinhold and Bradley W. Duerstock (2008)	Chemistry connection	4	40%

During my research, I explored integrated STEM systems in chemical education, emphasizing interdisciplinary learning experiences and pedagogical improvement in a STEAM environment. My conclusions identify five key structures and principles: engineering design, project based, 3D printing, PBL (problem-based learning), and chemical design. These findings, derived from literature review and personal observations, offer insights into existing integrated STEM approaches in chemistry education and highlight principles for effective learning.

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5-9 СЫНЫП ОҚУШЫЛАРЫ ҮШІН STEM ТЕХНОЛОГИЯСЫН МАТЕМАТИКАҒА КІРІКТІРУ

Аннотация. 21 ғасырда оқушыларды күрделі мәселелерді шешуге дайындау үшін STEM (ғылым, технология, инженерия және математика) білім беру жүйесіне кіріктіру маңыздырақ болып отыр. Математика STEM негізі бола отырып, осы пәндерді біріктіруде маңызды рөл атқарады. Бұл мақалада 5-9 сынып оқушылары үшін STEM-ді математикаға енгізудің артықшылықтары мен стратегиялары қарастырылады. Көпір дизайны, ауа райы деректерін зерттеу, робототехника және қаржылық модельдеу сияқты математикалық мазмұнға STEM тұжырымдамаларын біріктіретін сабақтар мысалдары берілген. Мақалада STEM интеграциясы математикалық ұғымдарды тереңірек түсінуге ықпал ететіні, проблемаларды шешу және сыни тұрғыдан ойлау дағдыларын дамытатыны, математикаға қызығушылықты арттыратыны және оқушыларды STEM-ге қатысты салалардағы болашақ мамандық таңдауда үлкен мүмкіндіктеріне ие болатынын атап өтілген.

Кіріспе

21 ғасырда студенттерді күрделі мәселелерді шешуге дайындау үшін STEM (ғылым, технология, инженерия және математика) білім беру жүйесіне кіріктіру маңыздырақ болып отыр. STEM білім беру әртүрлі салалар мен салаларда табысқа жету үшін қажетті сыни ойлауды, мәселелерді шешуді және топта жұмыс істеу дағдыларын дамытады. Математика STEM негізі бола отырып, осы пәндерді біріктіруде маңызды рөл атқарады.

STEM-ті математикаға енгізудің пайдасы

STEM-ді математикаға интеграциялау оқушыларға бірқатар артықшылықтар береді, соның ішінде:

- Математикалық ұғымдарды түсінуді арттыру
- Мәселені шешу және сыни тұрғыдан ойлау дағдыларын дамыту
- Математикаға деген қызығушылықтарын арттыру
- STEM салаларындағы болашақ мансапқа дайындалу