ISSN 2663-8169 Vol. 6, Issue 11: 140-145, DOI: 10.25236/IJNDE.2024.061122

Strategies for Vocational Chemistry Teaching Based on the STSE Educational Concept

Lilei Wang*

School of Chemistry and Chemical Engineering, Taishan University, Tai'an, China
**Corresponding author: llwang@tsu.edu.cn*

Abstract: *This study explores the application and strategies of the Science, Technology, Society, and Environment (STSE) educational concept in vocational chemistry teaching. It begins by examining the theoretical foundations and historical development of the STSE concept, analyzing the current state of vocational chemistry teaching and its deficiencies in cultivating students' scientific literacy, critical thinking, and social responsibility. Based on these findings, the study proposes a teaching strategy centered on the STSE concept, including curriculum integration, problem and project-driven teaching methods, and the combination of experiments with real-world social issues. Case studies are used to discuss the effectiveness and challenges of this strategy in actual teaching practice, offering feasible solutions. The findings demonstrate that the STSE educational concept can significantly enhance the quality of vocational chemistry teaching and promote the development of students' comprehensive abilities. This paper provides theoretical support and practical guidance for educational reforms in vocational education.*

Keywords: *STSE educational concept; vocational chemistry teaching; teaching strategies; curriculum design; problem-driven learning*

1. Introduction

In recent years, the rapid development of society and technology has brought widespread attention to the Science, Technology, Society, and Environment (STSE) educational concept in the field of education. As an educational approach centered on developing students' comprehensive abilities and social responsibility, STSE emphasizes the application of scientific and technological knowledge in social and environmental contexts, aiming to help students understand science in real-world scenarios, solve practical problems, and assume social responsibilities. In chemistry teaching, the introduction of the STSE concept not only enhances practical and innovative aspects of teaching but also increases students' interest and subject literacy. However, the current vocational chemistry teaching model is still largely focused on knowledge transmission, with students' hands-on skills and comprehensive application abilities needing further improvement.Vocational education, as an important component of the educational system, requires students to possess strong practical abilities and professional skills. Therefore, exploring how to effectively integrate the STSE educational concept with vocational chemistry teaching and designing teaching strategies tailored to students' characteristics has become a critical issue in improving teaching quality. This paper systematically analyzes the connotation and value of the STSE concept and discusses its application strategies in vocational chemistry teaching, aiming to provide theoretical and practical support for educational reform in vocational institutions and better meet the demand for highly skilled applied talents. Through this research, we will examine aspects such as curriculum design, teaching method improvement, and teaching outcome evaluation, proposing innovative strategies based on the STSE concept and analyzing potential challenges and solutions[1].

2. Theoretical Foundations of the STSE Educational Concept

2.1. The Origin and Development of the STSE Educational Concept

The STSE educational concept emerged in the late 20th century as a multidisciplinary educational perspective in response to evolving social needs and educational goals. Representing science, technology, society, and environment, STSE emphasizes the integration and consideration of these dimensions to develop students' abilities to solve real-world problems in complex social environments. Initially appearing in science education, it focused on the close connection between scientific knowledge and social needs. With rapid technological advancement and increasing environmental awareness, the STSE concept gained recognition among educators worldwide. It not only prioritizes the dissemination of scientific knowledge but also highlights the impact of science and technology on social progress and environmental challenges.Over its developmental history, the STSE concept has transformed from discipline-centered science education into a comprehensive educational framework. In the 1970s, countries in Europe and North America began incorporating science, technology, and social issues into classroom teaching, using societal hot topics to engage students in thinking about practical scientific applications. Subsequently, the STSE concept evolved into a systematic educational theory emphasizing the interrelationships and impacts among science, technology, society, and the environment, advocating for experiential and practical learning activities to enhance students' comprehensive abilities. In recent years, with the increasing urgency of global environmental issues, technological innovation, and social development, the application and research scope of the STSE concept has further expanded, becoming a prominent area of focus in education.In China, the introduction and development of the STSE concept occurred relatively late, but its role in driving educational reform cannot be overlooked. As curriculum reform continues to deepen, more schools and educators recognize that the simple transmission of subject knowledge no longer meets students' needs for comprehensive development. Therefore, applying the STSE concept in vocational chemistry teaching is not only a response to social and market demands but also an important approach to enhancing students' comprehensive literacy and practical abilities[2].

2.2. Core Elements and Theoretical Foundations of the STSE Concept

The STSE concept is built on four core elements: science, technology, society, and environment. It emphasizes their interconnections and comprehensive applications to develop students' abilities to solve complex social problems. Science is a central dimension, representing the exploration of natural phenomena and the understanding of knowledge systems, stressing the mastery of basic scientific knowledge and inquiry methods. Technology, as the applied and practical dimension of science, bridges theory and reality, fostering students' innovative and practical skills. The social dimension reflects the application and impact of science and technology on society, focusing on how they address social issues, improve human life, and their ethical and value implications. The environmental dimension emphasizes the impact of science and technology on the natural world, promoting sustainability and cultivating students' responsibility and action for environmental protection.The theoretical foundations of STSE education include constructivist learning theory, systems thinking theory, and situational learning theory. Constructivist learning theory posits that learning is an active process of building knowledge, where students internalize and understand knowledge through exploration and experience. Thus, STSE education emphasizes learning science and technology in real contexts to stimulate students' interest and self-directed inquiry. Systems thinking theory highlights complex relationships and interactions, which the STSE concept integrates through cross-disciplinary approaches to help students form a comprehensive understanding. Situational learning theory holds that knowledge learning and application must be context-specific, and STSE education utilizes real-world problem scenarios to enhance students' cognitive and practical abilities.In practical teaching, the core elements of STSE require educators to design comprehensive and practice-oriented activities, focusing on students' application of science and technology in societal and environmental contexts. By guiding students to engage in projects and explore social and environmental issues, STSE education fosters innovation, critical thinking, and social responsibility, preparing them for future complex challenges[2].

3. Analysis of the Current State of Vocational Chemistry Teaching

3.1. Characteristics and Objectives of Vocational Chemistry Courses

Vocational chemistry courses, as essential foundational courses for science and engineering majors in vocational institutions, are characterized by their strong application, practical orientation, and emphasis on industry needs. Unlike general chemistry courses in higher education, vocational chemistry focuses on integrating theoretical knowledge with professional practice to meet industry and enterprise demands for skilled talent. Thus, the course design is practice-oriented, covering fundamental chemical theory, experimental skills, and industry-related chemical applications. Students are expected not only to grasp basic chemical concepts but also to solve practical production problems and apply their knowledge flexibly in professional settings.The objectives of vocational chemistry teaching extend beyond transmitting chemical knowledge and skills to fostering students' professional qualities and

ISSN 2663-8169 Vol. 6, Issue 11: 140-145, DOI: 10.25236/IJNDE.2024.061122

comprehensive capabilities. Specifically, the goal is to systematically impart chemical knowledge and skills, enabling students to develop experimental proficiency, problem-solving abilities, and enhance their professional competencies. Additionally, the curriculum emphasizes cultivating students' professional ethics and awareness, incorporating safety, environmental protection, and innovation to ensure they demonstrate high professional standards at work[3]. Engaging students in chemistry experiments and project-based learning aims to spark their interest and exploratory spirit, laying a strong foundation for future career development.However, several challenges exist in achieving these objectives. Current teaching models often emphasize theoretical knowledge over practical skills and professional literacy, leaving students inadequately prepared for real-world tasks and innovation. Furthermore, limited teaching resources and outdated laboratory equipment in some institutions hinder the effectiveness of practice-oriented training. Consequently, optimizing the integration of theory and practice in vocational chemistry teaching remains a key challenge to improving teaching quality[4].

3.2. Strengths and Weaknesses of Existing Teaching Models

The current vocational chemistry teaching models exhibit notable strengths and weaknesses based on years of practice. On the positive side, vocational chemistry teaching emphasizes practical application, aligning curriculum content with industry needs through laboratory courses and hands-on training, thereby helping students acquire practical chemical skills. Many institutions collaborate with enterprises to offer industry-based projects, exposing students to real-world production environments and enhancing their professional adaptability. Additionally, some institutions adopt diversified teaching methods, such as project-based, case-based, and problem-driven learning, to improve students' independent learning and overall competencies. Moreover, the increasing integration of modern information technology, such as blended learning, offers flexible learning pathways.Nevertheless, several weaknesses remain. One major issue is the disconnect between theory and practice. Despite an emphasis on practical training, many courses still focus primarily on theoretical instruction, leaving students' hands-on skills underdeveloped. The slow pace of curriculum updates, which fail to reflect new industry technologies and needs, further exacerbates this issue, making some content outdated and less relevant to modern production. Limited teaching resources and aging laboratory equipment in some institutions also restrict comprehensive practical training. Additionally, some teachers lack mastery of modern pedagogical concepts and vocational education practices, resulting in monotonous teaching methods that fail to engage students. Finally, a single-track student evaluation mechanism limits the comprehensive assessment and enhancement of students' practical and innovative abilities, often focusing solely on exam performance while neglecting hands-on skills and creativity.In summary, while current vocational chemistry teaching models possess certain strengths, there are many areas requiring improvement. To truly cultivate highly skilled and competent talent, teaching models must be optimized to integrate theory and practice effectively, update curriculum content, and enhance teacher capabilities[5].

4. The Value of Applying the STSE Educational Concept in Vocational Chemistry Teaching

4.1. Promoting Students' Scientific Literacy

The STSE (Science, Technology, Society, and Environment) educational concept emphasizes contextualized teaching through real-world issues, allowing students to learn scientific knowledge within authentic social and environmental contexts. Applying this concept in vocational chemistry teaching holds significant value for cultivating students' scientific literacy. Scientific literacy extends beyond mastering theoretical knowledge in chemistry; it encompasses students' thinking processes, practical abilities, and their understanding of the application and impact of science and technology in society. Through STSE education, vocational students can comprehensively understand the importance of chemistry in social and environmental contexts, enhancing their abilities to analyze and solve real-world problems.In practical applications, the STSE concept introduces chemistry issues closely related to students' lives and careers, linking their learning with real-life situations. For example, during lessons on acid-base reactions, incorporating case studies on environmental pollution control can demonstrate the practical use of chemical reactions in wastewater treatment. This teaching approach enables students to not only grasp the relevant chemical knowledge but also to develop their ability to apply scientific principles to social and environmental challenges[6]. The contextual and integrative nature of STSE education helps strengthen students' scientific thinking, allowing them to analyze and resolve complex problems from multiple perspectives.Furthermore, STSE education emphasizes the cultivation of critical thinking and independent reasoning. By guiding students to explore the societal and ethical implications

ISSN 2663-8169 Vol. 6, Issue 11: 140-145, DOI: 10.25236/IJNDE.2024.061122

of science and technology, students not only deepen their understanding of chemical knowledge but also develop a profound awareness of the direction of scientific and technological advancements. This educational model encourages students to foster a spirit of scientific inquiry and social responsibility, preparing them to take on greater social and environmental responsibilities in their professional careers. Therefore, applying the STSE concept in vocational chemistry teaching can effectively enhance students' overall scientific literacy, producing well-rounded and innovative professionals who are prepared to meet societal needs[7].

4.2. Enhancing the Connection Between Chemistry and Real-World Social Issues

Applying the STSE educational concept in vocational chemistry teaching can significantly strengthen the connection between chemistry knowledge and real-world social issues, making students aware that chemistry is not merely theoretical concepts and reactions confined to laboratories but a critical tool for solving societal, technological, and environmental problems. In traditional chemistry teaching, students often focus on learning formulas and chemical equations without sufficient understanding or experience of chemistry's practical applications in society. STSE education bridges this gap by bringing social issues, technological challenges, and environmental needs into the classroom, helping students gain a deeper understanding of the role and impact of chemistry in the real world.Specifically, STSE education incorporates socially relevant cases, experiments, and projects into teaching, aiding students in understanding the practical applications of chemistry knowledge. For example, in addressing environmental pollution issues, instructors can design course modules centered around chemical treatment technologies, allowing students to study the composition and remediation methods of pollutants, thereby enhancing their awareness of the relationship between chemistry and environmental protection. This approach enables students to understand and apply chemical theories while solving real-world social issues, stimulating their learning interest and innovative capabilities.Additionally, the STSE concept emphasizes the societal impact of science and technology, guiding students to reflect on how advancements in chemical technology affect society and the environment. For example, discussions on the chemical properties of new energy materials can be linked with current societal demands for renewable energy, exploring the contribution of new materials to reducing carbon emissions and the challenges of technological implementation. This teaching model not only enhances students' professional skills in chemistry but also raises their awareness of the multidimensional relationships among chemistry, society, economy, and environment, cultivating social responsibility and innovative thinking.By tightly integrating chemistry with real-world social issues, STSE education can bridge the gap between theoretical knowledge and practical application in traditional chemistry teaching, helping students develop problem-solving abilities and sensitivity to societal needs. This approach better equips them for future career development and social engagement[8].

4.3. Developing Students' Critical Thinking and Comprehensive Abilities

The application of the STSE educational concept in vocational chemistry teaching plays a crucial role in developing students' critical thinking and comprehensive abilities. Critical thinking involves the ability to analyze, evaluate, and reflect on knowledge during scientific exploration, while comprehensive abilities enable students to integrate and apply various knowledge and skills to solve complex problems. Traditional chemistry teaching often focuses on the transmission of theoretical knowledge, with a heavy reliance on memorization and repetition, providing limited opportunities for students to think critically or apply knowledge comprehensively. The STSE concept offers a platform for developing these abilities by guiding students to apply chemistry knowledge to social and environmental issues.In the STSE educational model, teaching design typically encourages students to reflect on the far-reaching impacts of science and technology on society and the environment, prompting them to analyze the pros and cons of technological applications and propose rational solutions through discussion and collaborative exploration. For example, when discussing the relationship between chemical processes and environmental pollution, students must analyze the environmental impact of chemical processes, propose innovative pollution reduction solutions, and present their arguments. This teaching model fosters students' critical thinking and enhances their ability to tackle complex problems.Moreover, STSE education emphasizes interdisciplinary integration and comprehensive application. During teaching, instructors often introduce knowledge from multiple disciplines, enabling students to understand and resolve chemistry-related issues from diverse perspectives. For instance, a project focused on water pollution control would require students to grasp chemical reaction principles while also acquiring knowledge in environmental science, engineering technology, and socio-economic factors. Such practical activities allow students to develop interdisciplinary collaboration skills and holistic problem-solving

ISSN 2663-8169 Vol. 6, Issue 11: 140-145, DOI: 10.25236/IJNDE.2024.061122

capabilities while learning chemistry.In conclusion, STSE education uses diversified teaching activities and interdisciplinary approaches to help students acquire critical thinking and comprehensive skills while learning chemistry. This approach prepares them to tackle real-world problems by integrating and applying a broad range of knowledge and skills, equipping them to address complex social and environmental challenges and meet future professional and societal needs[9].

5. Designing Teaching Strategies Based on the STSE Educational Concept

To better integrate the STSE educational concept into vocational chemistry teaching and enhance students' comprehensive and practical abilities, it is essential to design a series of effective strategies tailored to teaching needs. These strategies should align with the application characteristics of chemistry knowledge, addressing social and environmental demands to strengthen students' understanding and application of science and technology in real-world contexts. Problem and project-driven learning strategies are a vital practice within the STSE concept, enabling students to master chemistry knowledge while solving real-world issues, fostering their innovative thinking and comprehensive abilities. Instructors can design a series of problems related to society, technology, and the environment as core teaching elements, such as exploring chemical wastewater treatment methods or new material applications in environmental protection. Through collaborative research, discussion, and experimental verification, students integrate chemistry knowledge, enhancing their analytical and problem-solving skills. Project-based learning stimulates student interest, promoting self-directed inquiry and teamwork while fostering social responsibility and critical thinking.Experimental teaching is a core aspect of vocational chemistry education, and the STSE concept emphasizes combining chemistry experiments with real-world societal needs, helping students recognize the practical role of chemistry in society. Instructors can design experiments related to social issues, such as monitoring and treating water pollution or ensuring food safety, enabling students to learn chemistry while considering its societal implications. Through such practical activities, students can gain a more intuitive understanding of the relationship between chemistry knowledge and practical application, enhancing their hands-on skills and innovative capabilities. Collaborating with industry projects can further immerse students in real-world professional contexts, enhancing their practical abilities and preparing them for future career demands. By employing these STSE-based strategies, vocational chemistry teaching can improve students' professional knowledge while cultivating critical thinking, social responsibility, and comprehensive skills, laying a solid foundation for their future professional development[10].

6. Specific Implementation Plan for STSE Teaching Strategies

To effectively apply the STSE educational concept in vocational chemistry teaching, a feasible implementation plan is necessary to achieve the organic integration of theory and practice, thereby enhancing students' comprehensive abilities. First, teaching objectives should encompass knowledge transmission, skill development, and the cultivation of social responsibility. Curriculum planning should focus on the integrated application of science, technology, society, and the environment, ensuring that teaching topics are related to real-world social issues and environmental challenges. This content design allows students to appreciate the practical value of chemical knowledge during their studies.The development and utilization of teaching resources are also crucial. Teachers can collaborate with enterprises and research institutions to develop practical case studies and projects, exposing students to the latest industry trends. Additionally, modern information technologies, such as virtual laboratories and multimedia teaching tools, can enrich the teaching content and provide flexible learning options for students. These resources help students learn and apply chemical knowledge in real-life contexts, sparking their interest and curiosity.Classroom activities and experimental arrangements should be centered around problems and projects, guiding students through inquiry-based learning to solve real-world issues. Teachers can design experiments related to social and environmental topics, such as chemical wastewater treatment or the development of new energy materials, allowing students to conduct research and analysis through group collaboration and hands-on experiments. This learning model fosters critical thinking and teamwork. Teachers should also emphasize safety awareness, practical skills, and an understanding of the societal impact of science and technology during experimental teaching.The evaluation of teaching outcomes and a reflection mechanism should not be overlooked. Evaluation methods should be diverse, covering knowledge mastery, practical skills, and social responsibility, and can include experiment reports, project presentations, and student self-assessments. Teachers should continuously reflect on and improve their teaching strategies based on evaluation results to ensure sustained teaching effectiveness. Additionally, regular communication with students can provide timely

ISSN 2663-8169 Vol. 6, Issue 11: 140-145, DOI: 10.25236/IJNDE.2024.061122

insights into their learning needs and feedback, further refining teaching plans.By implementing these strategies, the application of STSE teaching strategies in vocational chemistry education can effectively enhance students' comprehensive qualities, equipping them with the skills to address complex social and environmental challenges and laying a solid foundation for their future careers.

7. Conclusion

This paper explores the application strategies and value of the STSE educational concept in vocational chemistry teaching, emphasizing the integration of science, technology, society, and the environment to cultivate students' comprehensive abilities and social responsibility. Teaching strategies based on the STSE concept can effectively enhance the teaching outcomes of vocational chemistry by enabling students to master chemical knowledge through practice, solve real-world problems, and develop greater sensitivity to social and environmental issues. Through diversified teaching designs and implementation plans, vocational chemistry teaching can better meet the needs of society and industry, providing comprehensive support for students' career development. In the future, teaching models should continue to be optimized to further align education with societal demands.

References

[1] Wıyarsı, Antuni, Heru Pratomo, and Erfan Prıyambodo. "Vocational high school students' chemical literacy on context-based learning: a case of petroleum topic." Journal of Turkish Science Education 17.1 (2020): 147-161.

[2] Sotáková, Ivana, Mária Ganajová, and Maria Babincakova. "Inquiry-Based Science Education as a Revision Strategy." Journal of Baltic Science Education 19.3 (2020): 499-513.

[3] Wei, Bing. "The change in the intended Senior High School Chemistry Curriculum in China: focus on intellectual demands." Chemistry Education Research and Practice 21.1 (2020): 14-23.

[4] Pernaa, Johannes. "Possibilities and challenges of using educational cheminformatics for STEM education: A SWOT analysis of a molecular visualization engineering project." Journal of Chemical Education 99.3 (2022): 1190-1200.

[5] Rodríguez-Becerra, Jorge, et al. "Developing technological pedagogical science knowledge through educational computational chemistry: a case study of pre-service chemistry teachers' perceptions." Chemistry Education Research and Practice 21.2 (2020): 638-654.

[6] Çalık, Muammer, and Antuni Wiyarsi. "A systematic review of the research papers on chemistry-focused socio-scientific issues." Journal of Baltic Science Education 20.3 (2021): 360.

[7] Ngozi, P. Okafor. "Enhancing Science Process Skills Acquisition in Chemistry among Secondary School Students through Context-Based Learning." Science Education International 32.4 (2021): 323-330.

[8] DeKorver, Brittland, Ariel Chaney, and Deborah Herrington. "Strategies for teaching chemistry online: A content analysis of a chemistry instruction online learning community during the time of COVID-19." Journal of Chemical Education 97.9 (2020): 2825-2833.

[9] Maryanti, Rina, et al. "Analysis of curriculum for science education for students with special needs in vocational high schools." Journal of Technical Education and Training 13.3 (2021): 54-66.

[10] Devetak, Iztok, and Vesna Ferk Savec. "Chemical education research in Slovenia after 1991: A systematic review." CEPS Journal 10.1 (2020): 9-36.