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INVESTIGATING METHODS FOR DEVELOPMENT OF STEM CHEMISTRY TEACHER CAREERS

Abstract. This literature review investigates methods utilized in enhancing the skills and knowledge of educators in the fields of science, technology, engineering, and mathematics (STEM). Through a systematic analysis of relevant articles, this study aims to identify innovative methods and effective practices implemented in STEM teacher development programs. The review underscores the need for further research to empirically investigate the efficacy of different approaches and inform the development of impactful professional development initiatives for STEM educators. By exploring new avenues and leveraging evidence-based practices, this study aims to contribute to the advancement of STEM education and the cultivation of a skilled workforce for the future.

Keywords: STEM education, STEM Chemistry teacher, Career development.

Introduction

In the ever-evolving field of education Science, Technology, Engineering, and Mathematics (STEM) have emerged as cornerstones of academic and professional development. STEM education is an approach that integrates these disciplines, improves critical thinking, problem-solving skills, and technological literacy. Its significance lies not only in preparing individuals for specialized careers but also in cultivating a broader set of skills essential for navigating the challenges of the modern world. The objective of this study is to identify prevalent methods utilized in the development of STEM teachers.

Literature review

In numerous countries, the inclination towards selecting a STEM career, particularly in fields like chemistry, is diminishing. Certain studies indicate a decline in the choice of chemistry as a major and profession from high school to higher education. Interestingly, women tend to opt for chemistry more frequently than men at both high school and university levels, while minorities exhibit a greater preference for chemistry in high school but a reduced interest in higher education compared to non-minorities (Avargil, S., Kohen, Z., & Dori, Y. J, 2020). High school serves as a critical period for developing or shaping students' interests and career aspirations, particularly in STEM fields. Effective STEM education in high school emphasizes the relevance of STEM concepts to students' lives and future careers. By showcasing how STEM knowledge and skills are applied in various fields, educators can help students understand the practical significance of these subjects, making them more inclined to

pursue further studies in STEM. Science teachers play a pivotal role in shaping students' academic performance and their decisions to major in STEM fields. Supportive environments, encompassing emotional backing and career guidance, have a constructive relationship with students' expectations for their career outcomes and their belief in their own capabilities. For instance, exposure to science from an early age can shape students' interest in pursuing STEM careers, bolstering their confidence in their abilities and their aspirations for future success.

The significance of fostering individuals' development within the field of chemistry, as well as in STEM disciplines more broadly, is profoundly rooted in the foundation laid during their school education. Research consistently reveals that many professionals in chemistry-related fields attribute their career choice to the captivating experiences they had during their chemistry education at school. These formative educational experiences not only cultivate a fascination for the subject matter but also instill essential skills, knowledge, and a passion for scientific inquiry. Thus, investing in high-quality chemistry education at the school level not only nurtures future scientists and professionals but also serves as a crucial catalyst for innovation and advancement within the broader realm of chemistry and STEM disciplines. Career knowledge entails understanding a specific STEM occupation, such as chemistry, including its prerequisites and anticipated responsibilities. While crucial, STEM career knowledge has not received extensive examination, yet it warrants increased attention. The depth of one's familiarity with STEM careers significantly impacts their inclination towards pursuing a career in STEM fields. In essence, the greater one's awareness of STEM career options, the more likely they are to consider them as viable career paths. Lacking sufficient prior knowledge, students may overlook the possibility of pursuing a career in STEM (Shwartz, G., Shav-Artza, O., & Dori, Y. J, 2021).

Teacher training programs in STEM education commonly employ several methodological strategies, including project-based learning, problem-based learning, collaborative learning, ODR approach (observation/discussion/reflection), and design-based learning. Among these strategies, design-based learning emerges as particularly suitable for disciplinary integration. Additionally, two critical competencies emphasized in STEM education teacher training programs are design thinking and computational thinking. These competencies are considered transversal, indicating their relevance across various aspects of the educational process Rodríguez, C. M. A., González-Reyes, R. A., Ballen, A. B., Merchán, M. A. M., & Barrera, E. A. L. (2024).

The purpose of this study is to discern and identify various activities or methodologies aimed at fostering the growth and advancement of chemistry teachers` development.

Research question is what specific methods are utilized within development programs aimed at enhancing the skills and knowledge of chemistry teachers?

Methodology

During the review stage, the research utilized Web of Science (WoS) and Scopus, as well as Google Scholar databases employing the search term ([STEM AND development] and [STEM AND Trainings]). These databases were chosen for their reputation in publishing the latest and most relevant literature in the field, as well as their coverage of key journals in science education. The most suitable articles were selected from the filtered results.

Sampling

To achieve the goal, we reviewed 10 scientific works, including scientific journals, articles, and methodological books.

Article name (author, year of publication)	Description
Diep N.H., Hoai V.T.T., Son P.N., Nga P.T., Thuy H.T.P., Duc N.M, 2023	Enhancing the ability to design and orchestrate STEM educational initiatives for natural science educators.
Shwartz, G., Shav-Artza, O., & Dori, Y. J, 2021	Selecting Chemistry Across Various Educational and Career Phases: Chemists, Chemical Engineers, and Educators
Avargil, S., Kohen, Z., & Dori, Y. J, 2020	Factors Influencing STEM Bachelor's Degree Attainment and Career Choices: Insights from Sector, Gender, Income, and High School Majoring
Rodríguez-Martín, M., Vergara, D., & Rodríguez-Gonzálvez, P., 2020	Assessing the Efficacy of STEM Teacher Training Programs: An Experimental Study
Rodríguez, C. M. A., González-Reyes, R. A., Ballen, A. B., Merchán, M. A. M., & Barrera, E. A. L., 2024	Additional contribution to the previous literatures of training of STEM teachers
Rahman, N. A., Rosli, R., Rambely, A. S., Siregar, N. C.,	Effectiveness of STEM hands-on practical activity during professional development.

Capraro, M. M., & Capraro, R. M., 2022	
Huang, B., Siu-Yung Jong, M., Tu, Y.-F., Hwang, G.-J., Chai, C. S., & Yi-Chao Jiang, M., 2022	Exploring Professional Development Approaches of STEM Teachers
Debeş, G., 2018	Highlighting the significance of STEM seminars for teachers within a developing country

Data collection

I conducted a comprehensive review of STEM teacher development articles from reputable international journals using databases like Scopus and Web of Science. Utilize relevant keywords to identify articles focusing on teacher training methods. Systematically searched databases, screen retrieved articles, reviewed full texts, synthesized findings, assessed quality, and documented key insights for analysis.

Data analysis

The analysis focused on 8 articles pertaining to methods for STEM teacher development. These articles were categorized into four distinct methods: training, bachelor/master degree programs, practical work/hands-on activities, and seminars.

While the analysis provides valuable insights into the methods employed in STEM teacher development, the limited number of articles and potential selection bias are acknowledged as limitations. Further research is warranted to validate the effectiveness of these methods across diverse educational settings.

Result

Article (Author, Year)	Method/Activity name	Frequency	Percentage
Diep N.H., Hoai V.T.T., Son P.N., Nga P.T., Thuy H.T.P., Duc N.M., 2023.	Training	3	37.5 %

Manuel R , Diego V, Pablo R, 2020 Rodríguez, C. M. A., González-Reyes, R. A., Ballen, A. B., Merchán, M. A. M., & Barrera, E. A. L. (2024)			
Shwartz, G., Shav-Artza, O., & Dori, Y. J, 2021 Avargil, S., Kohen, Z., & Dori, Y. J, 2020	Graduation with a STEM bachelor's/ master’s degree	2	25 %
Debeş, G., 2018	Seminar	1	12.5 %
Rahman, N. A., Rosli, R., Rambely, A. S., Siregar, N. C., Capraro, M. M., & Capraro, R. M. (2022) Huang, B., Siu-Yung Jong, M., Tu, Y.-F., Hwang, G.-J., Chai, C. S., & Yi-Chao Jiang, M. (2022)	Practical work	2	25 %

Based on the analysis, training emerges as the most prevalent method for STEM teacher development, constituting 37.5% of the articles reviewed. This suggests that training programs for STEM teachers are not only effective but also more commonly utilized in the literature. Conversely, seminars for teachers, such as summer institute programs or short-term seminars, are less explored, with a lower

percentage of inclusion in the reviewed articles. This indicates that such seminar-based approaches may be less common or rare in the development of STEM chemistry teachers.

Conclusion

This analysis underscores the limited exploration and research surrounding the topic of STEM teacher development. The scarcity of literature suggests an unmet need for further investigation to expand the landscape of professional growth opportunities for STEM educators. By delving deeper into this area, future research can uncover innovative strategies and effective practices to enrich the training and support provided to STEM teachers. This will not only enhance the quality of STEM education but also contribute to the cultivation of a more robust and competent workforce in the fields of science, technology, engineering, and mathematics.

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