

THE ROLE OF NETWORKING AND INTERNATIONAL EXPERIENCES IN SHAPING STEM CURRICULA

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Abstract

In an ever-evolving, technology-driven world, STEM education (Science, Technology, Engineering and Mathematics) holds a central and vital place, equipping students with the knowledge and skills they need to confront 21st-century challenges. This paper examines the influential role of international networks and experiences in shaping pedagogical practices within the STEM education field, with a particular emphasis on the international network for STEM educators, Science on Stage Europe. Through a questionnaire, we aimed to gather data on educators' knowledge of STEM education, participation in professional development, utilization of STEM-focused curriculum or instructional materials, and, crucially, the pedagogical approaches they employ in their teaching. The collected data reveal diverse levels of familiarity with STEM education, a wide range of pedagogical approaches employed by educators, and a high interest in professional development to enhance their ability to integrate STEM education in their teaching methods. This paper recommends fostering collaboration between educational institutions and international organizations to facilitate the exchange of experiences among educators. This collaboration aims to strengthen the network of STEM educators in North Macedonia, providing them with international innovative experiences and practices to enhance the future development of STEM education in the country.

Keywords: STEM, curriculum, teachers, networking.

Introduction

In the 21st century, STEM (Science, Technology, Engineering, and Mathematics) education stands as a linchpin in preparing the next generation for the ever-evolving challenges of our technology-driven world (National Research Council, 2011). This succinct exploration underscores the paramount significance of STEM education, focusing on its pivotal role in cultivating essential skills, fostering innovation, and addressing global challenges.

STEM-focused education nonprofit leaders rely heavily on donor support to support and execute their organizations' goals. STEM organizations must also collaborate with educational institutions to meet their workforce needs. Many STEM-focused education nonprofit leaders lack the resources and strategies required to engage STEM-focused corporations. The background of this problem revolves around the engagement strategies available to STEM-focused education nonprofit organizations when collaborating with STEM-focused corporations. As leaders of STEM-focused education nonprofit organizations look to achieve their goals, engagement is crucial for the success of their missions (Kanas, 2022). With a focus on STEM interaction, driven by teachers, interventions can be developed to overcome these impediments. A focus on STEM integration will not overcome the barriers and may result in the decimation of technology as a distinct component of the school's core curriculum. A STEM orientation, therefore, must be approached with caution. (Williams, 2011).

STEM education serves as the bedrock for developing indispensable skills crucial for success (National Academy of Engineering & National Research Council, 2014). Mathematics and science foster analytical and problem-solving capabilities, while technology and engineering instill creativity and practical application. This interdisciplinary approach equips students with the ability to think critically and approach challenges systematically. To address the need for more science, technology, engineering, and mathematics (STEM) literate workers, both elementary and secondary classrooms are integrating STEM curriculum and pedagogy into their school day. It is important to our economy that schools be successful at producing students capable of talented contributions in STEM fields. To capitalize fully on the STEM potential of our students, schools must streamline STEM education and refine their instructional pedagogy. (Margot et al., 2019). Teachers appear to value STEM education and believe it enhances student-learning outcomes while preparing students for their future. With increased confidence, teachers would likely be more effective at integrating STEM activities. The research seems clear that increased confidence leads to better performance during instruction, and this will lead to gains in student learning (Nadelson et al., 2012; Nadelson et al., 2013).

According to Shernoff et al. (2017), STEM education is the use of science, technology, engineering, mathematics, and their associated practices, to create student-centered learning environments in which students investigate and engineer solutions to problems, and construct evidence-based explanations of real-world phenomena. Evidence-based STEM education promotes creativity and innovation while developing critical thinking, collaboration, and communication skills while students seek explanations about the natural world to improve the built world". This was a common conceptualization of integrated approaches to STEM education that was offered to all participants of the present study. STEM education still does not have the right approach in primary and secondary schools in the Republic of North Macedonia. STEM education has developed with more intensity in our schools since the implementation of the project '21st Century Schools' supported by the British Council. (Jashari, 2023), so Science on Stage North Macedonia is a good opportunity to support teachers with various educational materials, helping them to increase the quality of the learning process, as well as to develop ideas for STEM education.

This paper recommends fostering collaboration between educational institutions and international organizations to facilitate the exchange of experiences among educators. This collaboration aims to strengthen the network of STEM educators in North Macedonia, providing them with international innovative experiences and practices to enhance the future development of STEM education in the country.

The purpose of this research is:

- Collaboration with International Partners
- Government Support for STEM Integration
- Comprehensive Teacher Training Programs
- Promote Ongoing Professional Development
- Community Engagement and Awareness

Material and methods

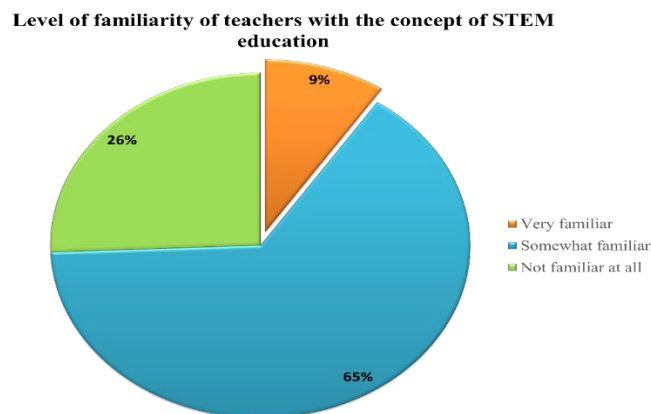
The data for this research was collected through a comprehensive questionnaire distributed during a dedicated session of the STEM teachers' network, Science on Stage Europe, organized under the auspices of Science on Stage North Macedonia. This strategic event provided an opportune platform for the engagement of educators passionate about STEM education. During this session, a total of 117 teachers actively participated by willingly and conscientiously filling out the questionnaire. The presentation served as an interactive forum, fostering a conducive environment for educators to share their experiences, insights, and challenges related to STEM

education. The questionnaire was meticulously designed to capture essential information, encompassing educators' knowledge of STEM education, their participation in professional development, the extent to which they utilize STEM-focused curriculum or instructional materials.

Following the enthusiastic participation of teachers, the collected survey data underwent a meticulous process of organization and analysis. Microsoft Excel was employed as the primary tool for data management, allowing for systematic categorization and quantitative examination of the responses. This rigorous methodology ensures the reliability and validity of the findings, contributing to the robustness of the study. By embedding the survey within the Science on Stage Europe event, the study leveraged the collaborative atmosphere, providing a rich context for educators to reflect on their practices and share valuable insights. The subsequent sections of this paper delve into the detailed results gleaned from this survey, shedding light on the diverse landscape of STEM education in North Macedonia and emphasizing the importance of international networks in shaping pedagogical practices within the field.

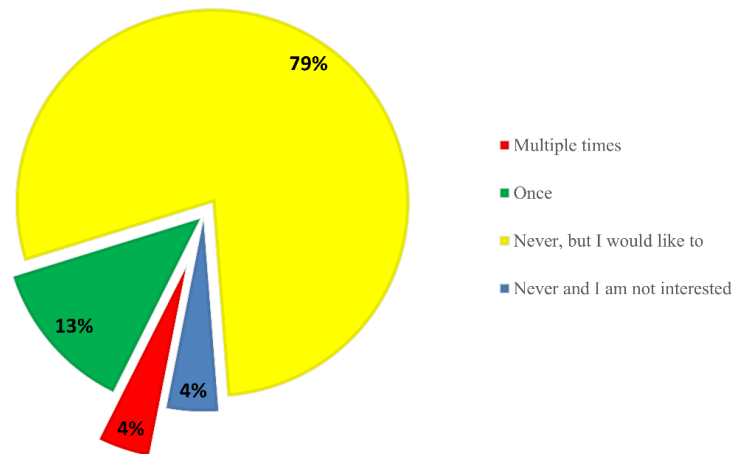
Results

The survey conducted among North Macedonian teachers provides a brief overview of the current landscape of STEM education awareness and professional development opportunities. The examination of teachers' familiarity with the concept of STEM education yielded diverse responses. Only 9% of educators expressed a high level of familiarity, while a majority of 65% reported being somewhat familiar, and 26% indicated a lack of familiarity with STEM education.

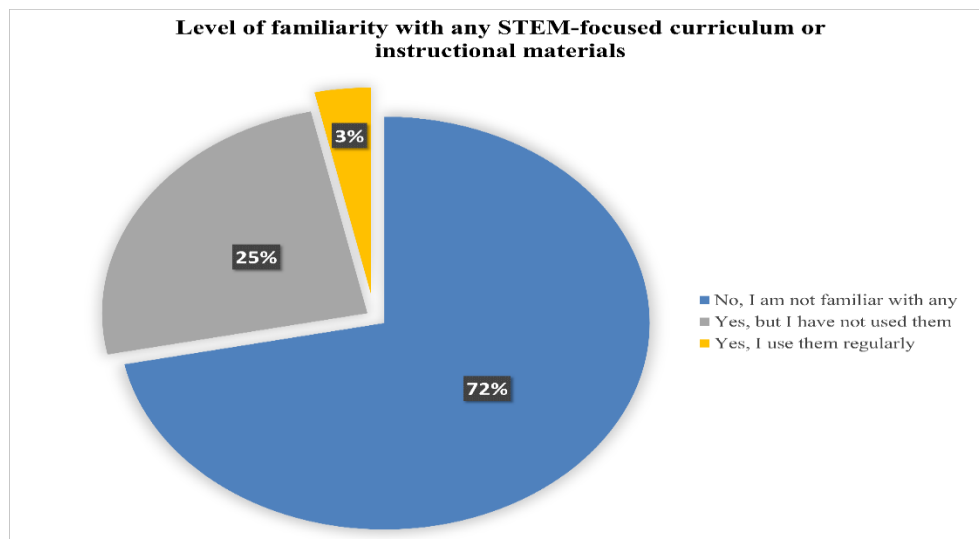


The survey delved into educators' participation in professional development opportunities specifically related to STEM education. Findings revealed that 4% of teachers attended such sessions multiple times, 13% attended once, and a substantial 79% expressed an interest but did not participate. A minimal 4% neither participated nor expressed an interest in professional development.

Participation in any professional development opportunities specifically related to STEM education

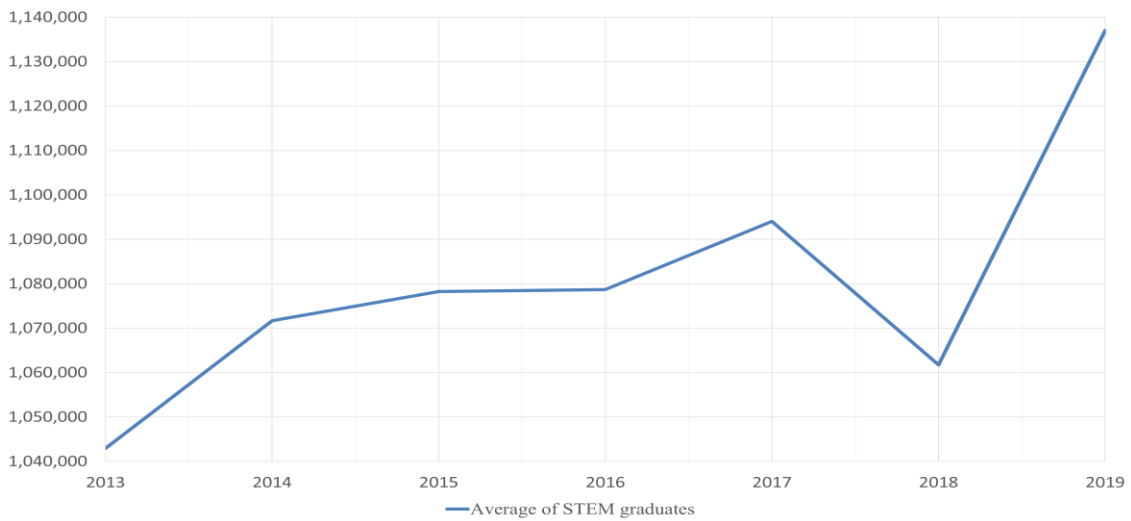


Interrogating teachers about their familiarity with any STEM-focused curriculum or instructional materials provided further insights. A substantial 72% of teachers reported not being familiar with any, while 25% acknowledged familiarity but had not utilized such materials. A minimal 3% reported regular usage.



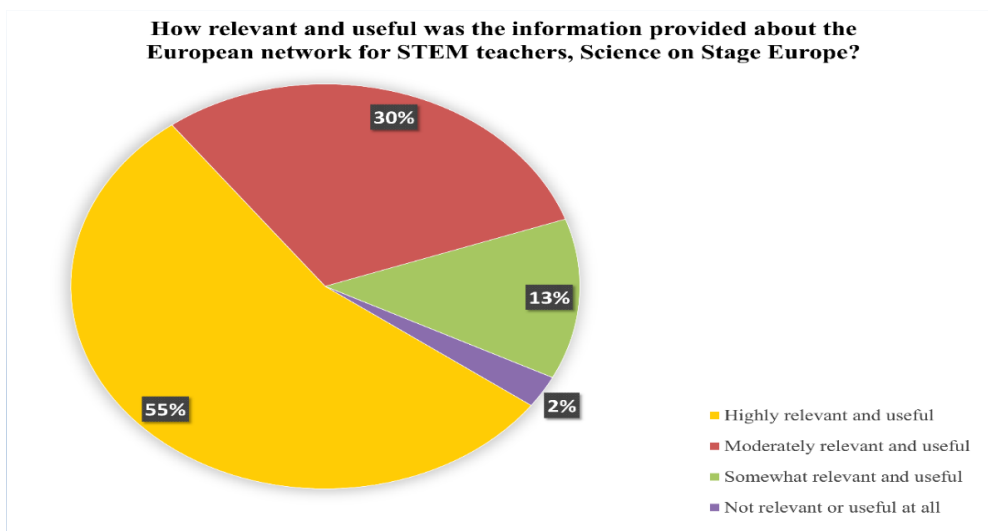
It is noteworthy to contextualize these findings within the broader European landscape. The Number of STEM graduates in Higher Education in the European Union (EU28) has shown a consistent increase from 2013 to 2019 (Eurostat, 2020).

Number of STEM graduates in Higher Education in European Union (EU28)

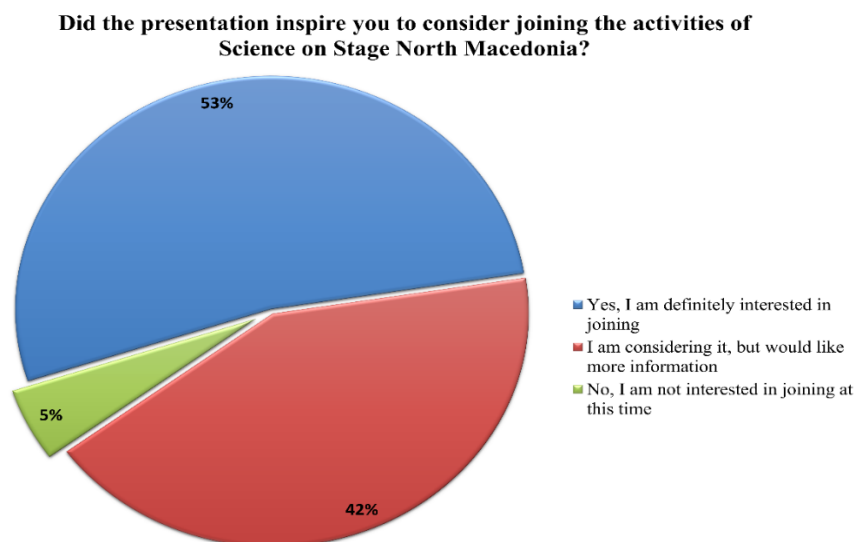


These results collectively highlight existing gaps in STEM education awareness and professional development opportunities among North Macedonian educators, where STEM education still lacks the appropriate approach in primary and secondary schools. The findings suggest a need for targeted interventions to enhance STEM education understanding and encourage participation in relevant professional development activities. Additionally, the reported lack of familiarity with STEM-focused instructional materials signals a potential area for improvement in the availability and dissemination of such resources within the North Macedonian education system. Addressing these gaps may require collaborative efforts, both domestically and internationally, emphasizing the role of networking and international experiences in shaping STEM curriculums and providing valuable insights for future educational initiatives in North Macedonia. The survey also included inquiries regarding the European network for STEM teachers, Science on Stage Europe, with participants providing feedback on the perceived relevance and usefulness of the information.

Participants were invited to evaluate the relevance and usefulness of the information provided about Science on Stage Europe. A significant majority, constituting 55% of respondents, deemed the information highly relevant and useful. Meanwhile, 30% assessed it as moderately relevant and useful. A minority, comprising 13%, found the information somewhat relevant and useful, while 2% of respondents said the material was not relevant or beneficial at all.



The survey further aimed to ascertain the interest of the participants to join the activities of Science on Stage North Macedonia after the presentation. Outcomes revealed that 53% of participants showed a definite interest in joining, while 42% were contemplating participation but sought additional information. A marginal proportion, constituting 5%, indicated that they were not currently interested in joining.



These responses underscore the positive influence of the presentation on participants' perceptions of Science on Stage Europe and their interest to engage with Science on Stage North Macedonia. The findings suggest a noteworthy level of interest and potential engagement in the activities offered by this European network for STEM teachers. This positive response aligns with the broader objectives of fostering collaboration and networking among STEM educators in North Macedonia and beyond.

Discussion

The survey results unveiled diverse levels of familiarity with STEM education among North Macedonian educators (National Research Council, 2011). While the majority indicated some level of familiarity, a significant portion reported a lack of exposure to STEM education concepts. This finding suggests the presence of a potential gap in awareness that warrants attention. Institutional barriers, such as limited access to relevant training and resources, may contribute to this lack of familiarity (Margot et al., 2019). Addressing these institutional challenges is crucial for enhancing educators' understanding of STEM principles and their potential benefits.

The expressed interest in professional development opportunities related to STEM education is a positive indicator of educators' willingness to enhance their knowledge and skills. However, the study reveals a notable gap between interest and active participation. This aligns with the study's objective of gauging educators' engagement in professional development. The identified institutional barriers, including a lack of dedicated funding and structured programs, shed light on potential obstacles hindering active involvement (Nadelson et al., 2012). Overcoming these barriers is essential to realizing the study's objective of promoting continuous learning and professional growth within the STEM education community.

Another key finding was the considerable percentage of educators not being familiar with any STEM-focused curriculum or instructional materials (Margot et al., 2019). This points to a potential gap in the availability and dissemination of educational resources within the North

Macedonian education system. Institutional barriers, such as a lack of standardized STEM curriculum and limited access to relevant materials, may contribute to this lack of awareness. Addressing these challenges is crucial for enhancing the quality of STEM education delivery. Cultural influences also play a role, as perceptions of the value and relevance of STEM education may vary within the cultural context of North Macedonia. Understanding and addressing these cultural influences are essential for developing effective strategies to promote awareness and utilization of STEM-focused curricula and materials.

The support and involvement of parents and the broader community play a vital role in the success of STEM education initiatives. Understanding the level of parental engagement and community support can provide insights into potential avenues for fostering a positive STEM learning environment. Exploring socio-economic factors adds another layer of complexity to the challenges faced in STEM education (National Academy of Engineering & National Research Council, 2014). Socio-economic disparities may impact access to resources, opportunities for professional development, and the overall educational experience for students. Teachers working in schools with limited resources may face additional challenges in implementing effective STEM education practices. Addressing socio-economic factors is vital for ensuring equitable access to STEM education opportunities for all students and educators. The availability of infrastructure, such as laboratories, technology resources, and internet access, can significantly impact the implementation of STEM education. Insufficient infrastructure may hinder hands-on learning experiences and limit students' exposure to cutting-edge technologies. Engaging with industry partners can enrich STEM education by providing real-world applications and insights. Examining the level of collaboration between educational institutions and industry partners can shed light on opportunities to enhance the practical relevance of STEM education.

The findings align with existing literature on STEM education, emphasizing the importance of addressing awareness gaps, promoting professional development, and enhancing the integration of STEM-focused materials in teaching practices (Margot et al., 2019; Nadelson et al., 2012). This alignment strengthens the validity and relevance of the study within the broader context of STEM education research. It is crucial to acknowledge the limitations of this study, such as potential biases in self-reported survey data. Future research could delve deeper into the specific challenges educators face in adopting STEM education practices, with a focused exploration of institutional, cultural, socio-economic, and conceptual factors. Understanding these factors in greater detail will contribute to the development of targeted interventions and strategies to overcome challenges effectively.

This research contributes to the ongoing discourse on STEM education by offering nuanced insights into the current landscape in North Macedonia. The identified gaps and challenges, influenced by institutional, cultural, socio-economic, and conceptual factors, provide a foundation for future initiatives aimed at strengthening STEM education practices in the country.

Conclusion

In summary, this study identifies the essential aspects of STEM education in North Macedonia. The findings underscore limited familiarity among educators with STEM education, highlighting the need for targeted initiatives to increase awareness and comprehension. Furthermore, the research identifies a pronounced shortfall in educators' participation in professional development opportunities specific to STEM education, accentuating the urgency of establishing avenues for the enhancement of STEM knowledge and pedagogical skills. Additionally, a notable lack of awareness regarding STEM-focused instructional materials signals a need for enhancements in the availability of educational resources within the North

Macedonian educational landscape. Conversely, the study reveals a noteworthy interest among educators in joining international STEM networks, pointing to a potential avenue for collaborative engagement and professional development within the broader global STEM education community. Attending to these identified challenges while leveraging international networks presents a promising trajectory for advancing STEM education in North Macedonia and aligning it with internationally recognized best practices.

Recommendations

The study proposes strategic recommendations to strengthen STEM education in North Macedonia. Firstly, targeted professional development programs should be designed to address educators' gaps in familiarity and pedagogical skills. Collaborative engagement with international STEM networks, exemplified by initiatives like Science on Stage Europe, is crucial for knowledge exchange and exposure to global best practices. Simultaneously, enhancing the STEM curriculum and creating a centralized repository for instructional materials will bolster educators' resources and support. The establishment of localized teacher networks and advocacy campaigns, supported by institutional and governmental support, are essential to the long-term viability of STEM education programs. To address socio-economic factors by advocating for equitable access to resources, including technology, infrastructure, and extracurricular opportunities. This ensures that all students, regardless of socio-economic background, can actively participate in STEM education. Foster parental and community involvement in STEM education initiatives. Establish communication channels to keep parents informed about the benefits of STEM education and engage the broader community in supporting STEM learning experiences. These recommendations collectively aim to address challenges, stimulate collaboration, and position North Macedonia as an active participant in the global STEM education landscape.

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