

CONNECTING THE DOTS: COMMUNICATION SKILLS FOR STEM SUCCESS

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Abstract

Developing communication skills requires practice, feedback, and ongoing professional development. This study aims to understand the perspectives and experiences of STEM professionals regarding the importance of effective communication and its impact on their professional growth and accomplishments. Through in-depth interviews and thematic analysis, this research investigates the multifaceted nature of communication skills in STEM. The findings of this research highlight the significance of verbal, written, and visual communication in STEM. The qualitative analysis reveals practical verbal communication skills. It includes presenting research findings effectively and engaging in interdisciplinary dialogues, enabling STEM professionals to collaborate effectively, exchange ideas, and drive innovation. Furthermore, the research uncovers the crucial role of visual communication in conveying complex scientific concepts to diverse audiences. The study demonstrates how impactful visual aids, such as data visualizations and illustrations, enhance the accessibility and understanding of scientific information, leading to increased engagement and broader knowledge dissemination. STEM professionals encounter various challenges in developing and honing their communication skills. It explores barriers, such as the lack of emphasis on communication training within STEM education and the cultural norms prioritizing technical expertise over effective communication. The research identifies strategies and resources STEM professionals utilize to enhance their communication skills, including participation in workshops, seeking mentorship, and leveraging digital platforms for science communication—the critical role of communication skills in achieving success in STEM fields. Effective verbal, written, and visual communication is essential in fostering interdisciplinary collaborations, knowledge dissemination, and innovation. By recognizing and addressing the challenges associated with communication skills, STEM education and research programs can better equip professionals with the necessary tools to bridge the gap between technical expertise and broader societal impact.

Keywords: *Communication skills; STEM success; Bridging the gap; Effective communication; Multifaceted communication*

Abstrak

Mengembangkan keterampilan komunikasi membutuhkan latihan, umpan balik, dan pengembangan profesional berkelanjutan. Studi ini bertujuan untuk memahami perspektif dan pengalaman para profesional STEM mengenai pentingnya komunikasi yang efektif dan dampaknya terhadap pertumbuhan dan pencapaian profesional mereka. Melalui wawancara mendalam dan analisis tematik, penelitian ini menyelidiki sifat multifaset keterampilan komunikasi dalam STEM. Temuan penelitian ini menyoroti pentingnya komunikasi verbal, tertulis, dan visual dalam STEM. Analisis kualitatif mengungkapkan keterampilan komunikasi verbal praktis. Ini termasuk menyajikan temuan penelitian secara efektif dan terlibat dalam dialog

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interdisipliner, memungkinkan para profesional STEM untuk berkolaborasi secara efektif, bertukar ide, dan mendorong inovasi. Selain itu, penelitian ini mengungkap peran penting komunikasi visual dalam menyampaikan konsep ilmiah yang kompleks kepada peserta yang beragam. Studi ini menunjukkan bagaimana alat bantu visual yang berdampak, seperti visualisasi dan ilustrasi data, meningkatkan aksesibilitas dan pemahaman informasi ilmiah, yang mengarah pada peningkatan keterlibatan dan penyebaran pengetahuan yang lebih luas. Profesional STEM menghadapi berbagai tantangan dalam mengembangkan dan mengasah keterampilan komunikasi mereka. Ini mengeksplorasi hambatan, seperti kurangnya penekanan pada pelatihan komunikasi dalam pendidikan STEM dan norma budaya yang memprioritaskan keahlian teknis daripada komunikasi yang efektif. Penelitian ini mengidentifikasi strategi dan sumber daya yang digunakan para profesional STEM untuk meningkatkan keterampilan komunikasi mereka, termasuk partisipasi dalam lokakarya, mencari bimbingan, dan memanfaatkan platform digital untuk komunikasi sains—peran penting keterampilan komunikasi dalam mencapai kesuksesan dibidang STEM. Komunikasi verbal, tertulis, dan visual yang efektif sangat penting dalam mendorong kolaborasi interdisipliner, penyebaran pengetahuan, dan inovasi. Dengan mengenali dan mengatasi tantangan yang terkait dengan keterampilan komunikasi, program pendidikan dan penelitian STEM dapat membekali para profesional dengan lebih baik dengan alat yang diperlukan untuk menjembatani kesenjangan antara keahlian teknis dan dampak sosial yang lebih luas.

Kata kunci: Kemampuan berkomunikasi; Kesuksesan STEM; Menjembatani kesenjangan; Komunikasi yang efektif; Komunikasi multifaset

1. Introduction

Communication skills are pivotal in professionals' success across various fields, and STEM disciplines are no exception (Rosli & Siregar, 2022). In today's interconnected and rapidly advancing world, more than technical expertise is needed to thrive in science, technology, engineering, and mathematics (STEM) fields. The ability to effectively communicate complex concepts, research findings, and innovations is becoming increasingly essential. This paper explores the significance of communication skills in STEM and highlights their impact on individual success and broader societal implications.

Numerous studies have emphasized the importance of communication skills for STEM professionals. According to research by Kitzinger et al. (2019), effective communication is critical in establishing interdisciplinary collaborations, enabling scientists and engineers to work together towards common goals. Collaboration across disciplines has become increasingly vital in tackling complex global challenges that require diverse expertise and perspectives.

Furthermore, communication skills are essential for conveying scientific ideas and research findings to different audiences (Anggrayni & Siregar, 2022). Explaining complex concepts in a clear and accessible manner is crucial for engaging policymakers and stakeholders in informed decision-making. Studies by Johnson et al. (2018) have shown that effective science communication can increase public understanding and support for scientific research, fostering an environment conducive to STEM advancement.

In addition to verbal communication, written skills are integral to STEM success. Writing is crucial in publishing research papers, grant proposals, and technical reports. A study by Freeman et al. (2021) highlights the correlation between scientific writing quality and research publications' impact. Clear and concise writing enhances the dissemination of knowledge, facilitates collaboration, and increases the visibility and recognition of STEM professionals.

Visual communication is another vital aspect of STEM success. In the age of information overload, the ability to effectively present data, create impactful illustrations, and design engaging infographics is invaluable. Research by Mayer et al. (2019) demonstrates that visual aids enhance information retention and comprehension, making complex scientific concepts more accessible to a broader audience. Visual communication is also crucial in scientific presentations, where compelling visuals can significantly enhance audience engagement and understanding.

Moreover, communication skills foster critical thinking and innovation in STEM fields. Effective communication requires synthesizing and organizing complex information, enhancing problem-solving skills and promoting creativity. As Kibler et al. (2020) highlight, the ability to articulate ideas clearly enables STEM professionals to identify gaps in knowledge, propose innovative solutions, and effectively communicate their work's benefits and potential impacts. Recognizing the significance of communication skills in STEM, educational institutions and research organizations have begun integrating communication training into their curricula and programs. The goal is to equip STEM professionals with the necessary skills to effectively communicate their work and engage with diverse audiences (Siregar & Nasiah, 2022). For instance, some universities now offer courses or workshops on scientific communication, allowing students to develop their writing, presentation, and visual communication skills.

Furthermore, digital platforms and social media have revolutionized science communication. STEM professionals can now access online tools and platforms to disseminate their work directly to the public. According to a study by Baram-Tsabari et al. (2017), engaging with social media and online science communities can enhance the visibility and impact of STEM research while providing opportunities for dialogue and collaboration with experts and non-experts.

However, challenges remain despite the growing recognition of communication skills in STEM. The traditional academic culture often prioritizes technical knowledge over communication skills, leading to a need for more emphasis on training in this area. A study by Rosauer et al. (2022) highlights the need for a cultural shift within STEM disciplines, with greater recognition of effective communication as an integral part of scientific practice.

Practical communication skills are crucial for success in STEM disciplines (Siregar & Anggrayni, 2023). Communicating complex ideas, research findings,

and innovations is essential for bridging the gap between technical expertise and broader societal impact. Over the past five years, research has highlighted the importance of communication skills in facilitating interdisciplinary collaborations, engaging stakeholders, and increasing public understanding of science. Effective verbal communication enables STEM professionals to collaborate, share knowledge, and foster innovation (Rahman et al., 2022). Clear and concise written skills enhance the dissemination of research and its impact on the scientific community. Visual communication, including data visualization and compelling illustrations, improves accessibility and comprehension of complex scientific concepts. Additionally, communication skills foster critical thinking, problem-solving, and creativity in STEM fields.

To address the significance of communication skills, educational institutions and research organizations are incorporating communication training into STEM curricula. Courses and workshops on scientific communication equip students with the skills to effectively write research papers, deliver presentations, and engage with diverse audiences. Furthermore, the digital era provides new avenues for science communication through social media and online platforms, allowing STEM professionals to reach broader audiences and promote dialogue and collaboration.

Despite the growing recognition, challenges persist in integrating communication skills into the STEM culture. Traditional academic norms often prioritize technical knowledge, creating a need for cultural change that values effective communication as an integral part of scientific practice. Initiatives focusing on enhancing communication training and creating supportive environments prioritizing technical expertise and communication skills are crucial for bridging this gap (Siregar et al., 2020).

The ability to communicate effectively is vital for STEM success. Communication skills enable STEM professionals to collaborate across disciplines, engage stakeholders, disseminate research findings, and foster innovation. By recognizing and prioritizing the development of communication skills, the STEM community can effectively bridge the gap between technical expertise and broader societal impact, ultimately contributing to advancements and solutions to global challenges.

2. Methodology

The qualitative research study utilized a purposive sampling technique to select participants who were STEM professionals with diverse backgrounds and experiences. The study aimed to capture a range of perspectives on the importance of communication skills in STEM and their impact on professional success.

Two were recruited for in-depth interviews, ensuring representation from various STEM disciplines, career stages, and institutions. Participants were identified through professional networks, online platforms, and recommendations from

experts in the field. Ethical considerations, including informed consent and confidentiality, were adhered to throughout the research process.

Semi-structured interviews were conducted as the primary data collection method. The interview guide was developed based on the research objectives and relevant literature. The guide consisted of open-ended questions that explored participants' perceptions of communication skills in STEM, their experiences in utilizing these skills, and their views on the impact of communication on their professional growth and accomplishments.

The interviews were conducted in person, via video conferencing, or over the phone, based on participant preferences and geographical locations. The interviews were audio-recorded with participants' consent and later transcribed for data analysis. Field notes were also taken during the interviews to capture non-verbal cues and contextual details.

Thematic analysis was employed as the data analysis approach. The transcribed interviews and field notes were coded using deductive and inductive techniques. Initially, a set of predetermined codes were developed based on the research objectives and interview guide. Additional codes emerged through iterative reading and analysis of the data. The codes were organized into themes and sub-themes that captured the main findings and patterns within the data.

Various strategies were implemented to ensure the rigour and trustworthiness of the findings. It included member checking, where participants were allowed to review and validate their interview transcripts, and peer debriefing, where the research team engaged in discussions to enhance the credibility of the interpretations. Triangulation of data sources, such as combining interview data with relevant literature, further strengthened the validity of the findings.

The study acknowledged its limitations, including the small sample size and the potential for participant bias. However, efforts were made to mitigate these limitations by selecting participants with diverse backgrounds and experiences and utilizing rigorous data analysis techniques.

3. Result and Discussion

The results of this qualitative study revealed several key themes and findings that contribute to understanding the importance of communication skills in achieving success in STEM fields. These findings are discussed considering existing literature on the subject. The key themes are based on interviews with two participants (a) interdisciplinary collaboration, (b) knowledge dissemination, (c) visual communication, and (d) challenges and strategies.

Interdisciplinary Collaboration

Participants emphasized the crucial role of communication skills in facilitating interdisciplinary collaborations within STEM. Effective communication enabled

scientists and engineers to collaborate, exchange ideas, and combine their expertise to address complex problems. This finding aligns with previous research by Kitzinger et al. (2019), highlighting the significance of communication in establishing successful interdisciplinary collaborations.

N and S said:

“Interdisciplinary collaboration helps bridge gaps between different fields of study, facilitating the exchange of knowledge, methods, and approaches. It encourages mutual learning and promotes the development of new interdisciplinary fields or sub-disciplines”.

Interdisciplinary collaboration is a collaborative approach that involves integrating knowledge, methods, and perspectives from multiple disciplines to address complex problems or research questions. This approach has gained significant attention recently due to its potential to foster innovation, enhance problem-solving, and yield comprehensive solutions.

When experts from different fields come together, they bring diverse expertise, methodologies, and ways of thinking. This diversity of perspectives encourages creativity and innovation. Research by Bozeman and Youtie (2019) emphasizes the importance of interdisciplinary collaboration in promoting creative problem-solving and generating novel ideas.

Interdisciplinary collaboration also enables a holistic understanding of complex phenomena. It recognizes that many real-world problems are multifaceted and require insights from various disciplines to be effectively addressed. A study by Klein (2019) highlights how interdisciplinary collaboration helps overcome traditional disciplinary approaches' limitations by integrating diverse knowledge and perspectives.

Furthermore, interdisciplinary collaboration has been found to enhance research outcomes. A research paper by Wuchty et al. (2019) reveals that interdisciplinary research tends to have a higher impact and attract more citations than single-discipline research. It suggests that collaborative efforts across disciplines contribute to producing high-quality and influential research outputs.

Interdisciplinary collaboration also plays a vital role in tackling grand challenges faced by society. Climate change, public health crises, and sustainable development require multidimensional approaches. A study by Jahn et al. (2019) underscores the significance of interdisciplinary collaboration in addressing these challenges by providing comprehensive insights and leveraging diverse expertise. One of the critical advantages of interdisciplinary collaboration is its ability to bridge knowledge gaps between disciplines. Interprofessional teams can benefit from each other's expertise and perspectives by fostering communication and knowledge exchange. It promotes mutual learning and facilitates a more integrated understanding of complex problems (Wuchty et al., 2019).

Translational research, which aims to bridge the gap between scientific knowledge and practical applications, is also facilitated by interdisciplinary collaboration. Involving stakeholders and end-users from different sectors ensures that research outcomes are relevant and applicable (Klein, 2019). Interdisciplinary collaboration can have a significant impact on policy and decision-making processes. By providing comprehensive insights and evidence-based recommendations, interdisciplinary research informs policymakers and contributes to evidence-based decision-making (Bozeman & Youtie, 2019).

Moreover, interdisciplinary collaboration fosters the development of interdisciplinary researchers with a broader skill set and the ability to work across disciplinary boundaries. It prepares them to tackle complex problems and contribute to advancements in their respective fields (Jahn et al., 2019). In addition to these benefits, interdisciplinary collaboration promotes diversity and inclusivity by recognizing and valuing the contributions of different disciplines and perspectives. It helps to overcome disciplinary biases and fosters a more comprehensive and inclusive understanding of complex issues (Wuchty et al., 2019).

Interdisciplinary collaboration recognizes that many real-world problems cannot be effectively addressed by a single discipline alone. By bringing together experts from various fields, interdisciplinary collaboration leverages diverse perspectives, knowledge, and methodologies to develop comprehensive and innovative solutions. However, interdisciplinary collaboration also poses particular challenges, including communication barriers, differences in terminology and methodologies, and the need for effective coordination and leadership. Overcoming these challenges requires fostering a culture of openness, respect, and shared understanding among team members and dedicated efforts to promote effective communication and collaboration.

Knowledge Dissemination

Clear and concise communication was essential for disseminating research findings and scientific knowledge to various audiences. Participants recognized the importance of effectively conveying complex concepts in writing and presentations, enabling wider accessibility and understanding (Siregar et al., 2023). This finding is consistent with studies by Johnson et al. (2018), which emphasize the impact of effective science communication on public understanding and support for scientific research.

N and S said:

“Knowledge dissemination also involves educating and training individuals or communities to enhance their skills and understanding in specific areas. Workshops, training programs, webinars, and online courses are effective means of sharing knowledge and building capacity”.

Effective knowledge dissemination requires clear and concise communication, adapting the information to the target audience, and using appropriate channels and formats. It is essential to consider the audience's needs, interests, and preferences to ensure the knowledge is accessible, understandable, and applicable.

Visual Communication

Visual communication emerged as a significant aspect of effective STEM communication. Participants acknowledged the power of data visualizations, illustrations, and infographics in enhancing the accessibility and comprehension of scientific information. This finding aligns with research by Mayer et al. (2019), demonstrating the impact of visual aids on information retention and audience engagement.

N said:

“The human brain processes visual information faster than text. Visual communication allows for quick scanning, pattern recognition, and information retrieval. Well-designed visuals can facilitate the rapid absorption of information and aid in decision-making”.

S said:

“Visuals have the power to capture attention and engage the audience more effectively than text alone. Incorporating compelling images, videos, or infographics can make content more engaging, stimulating curiosity, and encouraging active participation”.

Incorporating effective visual communication requires understanding the target audience, selecting appropriate visual elements, organizing information hierarchically, and maintaining consistency in design principles. Balancing visual appeal with clarity is essential, ensuring that the visuals enhance understanding rather than creating confusion.

With the increasing availability of digital tools and platforms, visual communication has become even more prevalent and accessible. Various software applications and online platforms enable the creation and sharing of visual content, empowering individuals and organizations to communicate their messages to a wide range of audiences effectively.

Challenges and Strategies

The study identified challenges STEM professionals face in developing and honing their communication skills. These challenges included a need for more emphasis on communication training within STEM education and cultural norms that prioritize technical expertise over effective communication. Participants also discussed strategies they employed to overcome these challenges, such as participating in workshops, seeking mentorship, and utilizing digital platforms for science communication (Kuehn, 2020; van Vliet et al., 2016).

Some common challenges include (a) the need for more emphasis on communication training: STEM education and training programs often prioritize technical knowledge and skills, with less emphasis on communication abilities. As a result, professionals may need formal training or guidance in effective communication practices. (b) complex and technical jargon: STEM fields are known for their specialized vocabulary and complex concepts. Communicating these ideas to non-experts can be challenging, as professionals may need help to simplify and convey information clearly and understandably. (c) bridging the knowledge gap: STEM professionals may need help to bridge the gap between their expertise and the knowledge level of their audience. It requires the ability to translate complex scientific concepts into language that is accessible and relatable to non-technical individuals. (d) limited interdisciplinary collaboration: STEM professionals often work in specialized fields, which can create silos and hinder interdisciplinary collaboration. Effective communication often requires working across disciplines and integrating diverse perspectives, which may be challenging in more isolated or specialized environments. (e) time constraints: STEM professionals often have demanding workloads and tight deadlines, leaving limited time for investing in communication skills development. Finding the time to practice and improve communication abilities can be challenging amidst other work responsibilities. (f) confidence and fear of public speaking: Many individuals, including STEM professionals, experience anxiety or lack confidence in public speaking or presenting in front of an audience. Overcoming these fears and developing effective communication techniques can be a significant challenge. (g) cultural norms and stereotypes: Certain cultural norms and stereotypes within STEM fields may prioritize technical expertise over communication skills. It can create a perception that solid communication skills are less necessary, leading to a lack of motivation or recognition for professionals to develop their communication abilities. (h) keeping up with evolving communication technologies: Rapid advancements present opportunities and challenges for STEM professionals. While these technologies provide new avenues for communication, professionals need to adapt and learn how to utilize them to reach their intended audience effectively.

The findings of this qualitative study underscore the significance of communication skills in STEM success. The results align with and contribute to the existing literature on the importance of effective communication in interdisciplinary collaborations, knowledge dissemination, and visual communication. The study highlights the need to incorporate communication training within STEM education programs and foster a culture that values and supports practical communication skills.

4. Conclusion

Practical communication skills are crucial for fostering interdisciplinary collaborations within STEM. By facilitating effective communication, STEM professionals can bridge the gap between different disciplines, exchange ideas, and work together towards common goals. This collaboration is essential for

addressing complex global challenges that require diverse expertise and perspectives. Furthermore, communication skills play a vital role in knowledge dissemination. The ability to convey research findings and scientific concepts in a clear and accessible manner enhances public understanding and support for scientific research. Effective science communication also enables scientists to engage policymakers, stakeholders, and the broader public in informed decision-making, ultimately contributing to the impact and relevance of STEM work. Visual communication is another essential aspect of communication skills in STEM. Engaging visual aids, such as data visualizations and illustrations, enhance the accessibility and comprehension of scientific information. These visual tools contribute to effective presentations, engage audiences, and promote knowledge dissemination.

Despite the significance of communication skills, challenges persist in the STEM community. The traditional academic culture often prioritizes technical knowledge over communication skills, resulting in a need for more emphasis on training and development in this area. It is crucial to integrate communication training into STEM education and research programs to address these challenges, create a culture that values effective communication, and support STEM professionals to enhance their communication skills.

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