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The competence, interest, and perceived self-efficacy of undergraduate students in science communication

Gasanguseyn I. Ibragimov [1*], Sergei P. Zhdanov [2], Nonna Y. Volosova [3], Svetlana A. Knyazeva [4], Svetlana V. Efimushkina [5], Lyubov V. Kochneva [6]

[1] Department of Pedagogy of Higher Education, Kazan (Volga region) Federal University, Kazan, RUSSIA
[2] Department of Civil Law Disciplines, Plekhanov Russian University of Economics, Moscow, RUSSIA
[3] Department of Criminal Law, Orenburg State University, Orenburg, RUSSIA
[4] Department of Medical and Social Assessment, Emergency and Ambulatory Practice, I. M. Sechenov First Moscow State Medical University, Moscow, RUSSIA
[5] Department of Physics and Mathematics, Moscow City University, Moscow, RUSSIA
[6] Department of Sociology, Psychology and Social Management, Moscow Aviation Institute, Moscow, RUSSIA

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Abstract

Science communication is an important part of science literacy that helps build trust in science, promotes the public interest, and supports informed decision-making on scientific issues. However, the literature lacks studies examining undergraduate student's competence, interest, and self-efficacy in science communication. This study investigated undergraduate student's competence, interest, and perceived self-efficacy skills in science communication. Two instruments were used to collect data from 226 undergraduate students in a public research university. The findings revealed that participants' competence and interest in science communication were moderate. The data shows that STEM students lack confidence in their ability to engage in science communication and are not particularly interested in it. The study found no significant differences in competence, interest, perceived self-efficacy, and gender. Likewise, no significant differences were found in competence and perceived self-efficacy across different grade levels. However, there was a significant relationship between participants' interests and their grade levels. The effect size was small for competence and interests in science communication. The conclusion discusses the implications of the findings for future studies.

Keywords: science communication, STEM, competence, interest, perceived self-efficacy

INTRODUCTION

In today's ever-changing scientific landscape and society, effective science communication is crucial to connecting the scientific community and the general public (Baram-Tsabari & Lewenstein, 2017; Fähnrich et al., 2021; Wu et al., 2019). In today's age of unprecedented technological advancements and complex global challenges, it is increasingly crucial for scientists to convey their discoveries clearly and understandably (Bammer, 2020; Fähnrich et al., 2021; Ishmuradova et al., 2023). A significant gap exists in college students' understanding of the effectiveness of science communication despite its acknowledged importance, as they are responsible for scientific discourse at some point (Chi et al., 2016; Ritchie et al., 2022). Scientific progress has moved rapidly, from groundbreaking discoveries in genomics to developing cutting-edge technologies such as artificial intelligence. In parallel with these developments, the global community struggles with multiple challenges, including climate change, health crises, biodiversity loss, and other issues (Panferov et al., 2022). In this complicated web of scientific progress and societal complexity, science communication is important in ensuring that the knowledge gained in the scientific

✉ guseinibragimov@yandex.ru **(*Correspondence)** ✉ zhdanov120009@yandex.ru ✉ kafedra_up@jur.osu.ru
✉ svknyazeva@mail.ru ✉ 7791svetik@mail.ru ✉ shafrans@mail.ru

Contribution to the literature

- The importance of science communication in strengthening trust in science, promoting public interest and facilitating informed decision-making on scientific issues for the general public is widely recognized. However, there is a lack of research in the existing literature that addresses the science communication skills of undergraduate students.
- Despite the recognized importance of science communication, there is a large gap in students' understanding of the effectiveness of science communication as they are at some point responsible for scientific discourse.
- The findings suggest that colleges and universities should provide science communication training, support students in developing their self-efficacy in science communication, and provide STEM students with opportunities to engage in science and public engagement.

community reaches the general public (Belayneh, 2021; Davies & Horst, 2016; Wu et al., 2019).

Despite the importance of science communication, researchers have no standard definition (Torras Melenchón et al., 2017). Scholars defined it as a cross-disciplinary mix that includes communication, psychology, education, philosophy, politics, sociology, natural, physical, and computer sciences (Burns et al., 2003; Mulder et al., 2008). Effective science communication is desirable (Baram-Tsabari & Lewenstein, 2017; Irwin, 2021; Leone & French, 2022). It serves as a channel through which scientific knowledge is disseminated and integrated into public understanding (Wu et al., 2019). It bridges the gap between the scientific community and the public. It promotes scientific literacy, which is essential when personal and political decisions are increasingly linked to scientific knowledge (Brossard & Shanahan, 2006; Cabreja-Castillo et al., 2023; Wu et al., 2019). Moreover, science communication is not a unidirectional process but a dynamic dialog that invites public engagement, critical discourse, and informed decision-making (Brossard & Shanahan, 2006; Cabreja-Castillo et al., 2023; Kawamoto et al., 2013; van Dijk, 2011).

Science communication allows students to engage with the public and various stakeholders (Wu et al., 2019). This engagement is important for building trust in science, promoting public interest, and supporting informed decision-making on scientific issues. Effective science communication skills enable students to share their knowledge with a broader audience, including the general public. This effectiveness helps disseminate scientific information and contributes to the public's understanding of complex scientific concepts. Improving science communication skills improves society's overall science literacy (Li & Guo, 2021). When students can communicate complex scientific concepts in understandable ways, they help foster a culture that values and understands science. College students' science communication skills are critical in advancing knowledge, engaging the public, influencing policy, and contributing to the ethical and responsible practice of science. These skills benefit individual career development and play a role in shaping a society that values and understands the importance of scientific research.

Despite the central role played by science communication, the research (e.g., Loroño-Leturiondo & Davies, 2018; Rose et al., 2020) focuses primarily on scientists, specifically their attitudes and experiences. One aspect that has been completely overlooked is science communication skills among college students, who are the budding minds who represent the future of science research and dissemination. This research problem arises from the realization that college students are not merely passive recipients of scientific knowledge. Rather, they are the potential ambassadors who can translate complex scientific concepts into accessible narratives for diverse audiences. For several reasons, understanding the factors that influence the effectiveness of college students' science communication is important. First, it is a proactive approach to cultivating a generation of future scientists in their fields who can communicate competently. Second, studying college students' communication skills is an asset in improving scientific literacy for having a science-literate society. By equipping students with effective communication skills, it is possible to empower them to be agents of knowledge dissemination in their communities. This contributes to a scientifically informed citizenry and breaks down the traditional barriers between science and the general public. Although the importance of science communication among college students is obvious, research on their competence, interest, and self-efficacies remains largely unexplored. Although science communication as a part of science literacy is important for undergraduate students to build trust in science, promote the public interest, and support informed decision-making on scientific issues for the public, the number of studies examining undergraduate students' science communication skills is limited in the literature. In particular, the number of studies examining undergraduate students' competence, interest, and self-efficacy skills is very little in the literature.

LITERATURE REVIEW

The importance of science communication among college students is evident, although there is limited study on their competence, interest, and self-efficacy in this area. While science communication plays a crucial role in enhancing science literacy among undergraduate students, fostering trust in science, advocating for the public interest, and facilitating informed decision-making on scientific matters, there is a scarcity of studies investigating the science communication skills of undergraduate students. Specifically, research is scarce in the literature investigating undergraduate students' competence, interest, and self-efficacy skills. Only a few studies examined the communication skills of students in STEM subjects. For example, Chi et al. (2016) developed an instrument to measure university students' perceived self-efficacy. Their findings demonstrated that the final modified instrument effectively assessed university students' perceived self-efficacy in their study. In their study, Torras Melenchón et al. (2017) investigated the impact of engaging in a science communication event on secondary school students' attitudes toward science and technology. The study's findings indicated that the students exhibited a greater inclination towards positive attitudes regarding science and technology after their involvement in the event. Notably, there were few apparent differences between male and female students. Chamely-Wiik et al. (2018) investigated a program's impact on doctoral students' proficiency in conveying their scientific research and expertise to audiences without technical knowledge. Their analysis showed that the students' communication skills had improved significantly during their participation in the program. Ritchie et al. (2022) found that STEM graduate students had a complex and multifaceted view of science communication. Leone and French (2022) examined the effects of science communication activities on students' science communication self-efficacy. In a virtual poster symposium, they examined students' perceptions. The researchers noticed a notable enhancement in students' science identity and communication skills. Additionally, they observed positive changes in the benefits and problems of presenting research digitally.

Alderfer et al. (2023) conducted a workshop on science communication for undergraduate students. Their results showed that the workshop increased students' science and science communication identities and their science and science communication self-efficacy. The study of Murphy and Kelp (2023) conducted a study on students' communication skills in science, their science identity, self-efficacy, and motivation. The findings indicated that while STEM students are willing to partake in community involvement endeavors, they frequently encounter a dearth of possibilities to engage in such activities actively. They also found that the academic year did not impact the students' attitudes and behaviors related to community engagement. In addition, the findings revealed that science communication skills, identity, and self-efficacy significantly influenced student motivation and behavior in engaging with the STEM community.

Research by Cameron et al. (2020) showed that active science communication mentoring increases young scientists' career interests. It is assumed that college curricula provide a comprehensive education that prepares STEM students to graduate as field experts. As noted by scholars (Amin et al., 2022; Fianti et al., 2020), Undergraduate students are required to possess effective communication skills in order to effectively disseminate their scientific knowledge and convey factual information on STEM subjects to both students and the general public. In the literature, there is little evidence of students' views of their competence, interests, and perceived self-efficacy in science communication and little research (e.g., Ritchie et al., 2022). The significance of science communication in fostering trust in science, advancing public interest, and facilitating informed decision-making on scientific matters for the general public is widely acknowledged. However, there is a lack of research examining the science communication skills of individuals pursuing undergraduate students, as evidenced by the limited number of studies in the existing literature. What is missing from the literature is a lack of comprehensive study that addresses the undergraduate students' competence, interest, and self-efficacy skills to have information in science communication among college students. Hence, this study attempts to fill this gap by taking a complete approach, considering the undergraduate students' competence, interest, and perceived self-efficacy skills. Consequently, this study examines undergraduate students' competence, interest, and perceived self-efficacy skills in science communication. To answer the research question, researchers used a quantitative data collection method to collect the data. The research was conducted using a survey method.

RESEARCH METHODOLOGY

Participants

The participants in this study were 226 undergraduate and graduate students enrolled in a university in Russia. They were from the biology, chemistry, and physics education departments. Personal information was collected on the students, including their age and gender. 226 responses from undergraduate students at a public research university were analyzed. The majority of participants were undergraduate students. A small proportion (11.5%) of participants were master's students. The participants' gender was 65.5% female and the rest male (34.5%). They were first-year students (42.9%), second-year students (18.1%), third-year students (18.6%), fourth-year students (8.8%), and master's students (11.5%). Due to ethical issues, researchers did not ask for their names and last names.

Data Collection Instrument

Researchers used a Likert-type data collection instrument to collect the data. Its first part was obtained from the study of Ritchie et al. (2022). This part included 8 items to determine participants' competence and interests in science communications. The researchers designed the first five items to assess participants' competence in effectively conveying general scientific concepts to the public. The last three statements were developed to assess the level of interest in disseminating general science topics to the general population. In their study, the researchers established a set of generic science concepts, including overarching subjects like climate change, stem cell research, nuclear waste, medicine development, gravitational waves, and other scientific concepts commonly highlighted in scientific news sources. The questionnaire consisted of statements rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The statements aimed to measure competence and interest in communicating general science concepts to the public. A higher score on these statements indicates greater proficiency and interest in science communication, implying a stronger identity as a science communicator.

The second part of the data collection instrument used in this research was developed by Chi et al. (2016) and Liu et al. (2014). They developed an instrument to measure university students' perceived self-efficacy in science communication with middle and high school students. The researchers designed and subsequently validated the instrument by employing a sample of undergraduate and graduate students. The researchers defined the term "*perceived self-efficacy*" as the college students' belief in their ability to effectively assist middle and high school pupils in understanding scientific subjects. The importance was placed on the recognition that science communication encompasses not only the student's knowledge of science-related concepts but also their understanding of the intended recipients of the information.

The findings of their study demonstrated that the revised instrument, consisting of 20 items, exhibited a strong fit, and the measures derived from this instrument displayed satisfactory levels of validity and reliability). They developed the scale as a Likert scale-type question format. Respondents were given a Likert scale to indicate their level of agreement with a statement, ranging from strongly disagree to strongly agree. The items in this instrument consisted of statements rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The statements aimed to measure the level of perceived self-efficacy in science communication and general science concepts to the public. A higher score on these statements indicates greater participants' perceived self-efficacy in science communication, implying a stronger identity as a science communicator.

Procedure

Two researchers translated the original versions of two data-gathering instruments into the local language. Subsequently, a proficient lecturer, well-versed in STEM education and the English language, was responsible for overseeing the instruments' translation process and providing constructive input to enhance the quality of the translated materials. Following the completion of this procedure, the researchers implemented revisions based on the input provided by the instructor. After the final revisions to the instruments, the translated versions were administered to a group of 20 undergraduate students who were not the primary subjects of this study. The researchers requested the participants to evaluate the readability and comprehensibility of the items contained inside two instruments. The participants provided little criticism to the authors to enhance the readability of the instruments. Upon obtaining feedback from the participants of this group, the authors considered their input and made the necessary revisions to finish the last edition of the scale.

Data Analysis

The researcher employed descriptive statistics and parametric statistical techniques to examine the data gathered in this study. Upon obtaining the dataset, the researchers searched for missing data within the collected information. The findings indicated that there were no instances of missing data within the dataset. Subsequently, the researchers decided to begin the analysis. Subsequently, the data passed normality testing in the statistical data analysis. The analysis of Skewness scores indicated that the data exhibited a normal distribution. The authors employed descriptive statistics, specifically mean and standard deviation scores, to report the findings about the items. The authors decided to employ parametric tests for data analysis to address the research issues in this study based on the obtained results. The authors employed an independent samples t-test to examine the differences in mean scores between genders and individuals. The researchers employed a one-way analysis of variance (ANOVA) test to examine the mean score variations among grade levels and participants. Due to differing sample sizes, the authors used the Bonferroni test as a post-hoc test to determine differences among grade levels.

Table 1. Participants' competence in science communication

No	Items	M	SD
1	I am confident I can communicate general science concepts to the students.	3.19	.99
2	I can accurately summarize and communicate general science concepts to the students.	3.07	1.05
3	I understand how to communicate general science concepts to the students.	3.10	1.09
4	I can overcome setbacks in communicating general science concepts to the students.	3.43	.99
5	Others ask me for help in communicating general science concepts to the students.	2.88	1.23
Total		3.13	.88

Note. M: Mean & SD: Standard deviation

Table 2. Participants' interests in science communication

No	Items	M	SD
6	I am interested in learning more about how to communicate general science concepts to the students.	3.26	1.270
7	Thinking about how to communicate general science concepts to the students excites my curiosity.	2.41	1.129
8	I enjoy learning about how to communicate general science concepts to the students.	3.25	1.197
Total		2.97	.99

Note. M: Mean & SD: Standard deviation

RESULTS

Competence & Interest Levels in Science Communication

Overall, the participants' competence and interest in science communication were evaluated with a mean of 3.13 and 2.97, respectively (**Table 1**). According to this result, it can be said that the participants' interest in science communication is low. This result shows that participants' competence in science communication is better than their interest. However, a mean score of 3.13 for participants' competence in science communication is not considered high. Thus, the results mean that the participants' competence and interest in science communication are moderate and low. These data show that STEM students do not believe they can engage in science communication and are not interested in it. However, these results are based on participants' self-assessments.

Table 1 shows that four items on competence had a mean of 3.0 and 3.5. Only one item, 5, "others ask me for help in communicating general science concepts to the students," had a low mean compared to the other items. Of the student responses to the items, the highest mean was found for item 4. This item refers to setbacks in teaching general science concepts to students. The lowest mean was found for the 5th item, which refers to asking for help from other participants in communicating general science concepts to students.

Table 2 shows three items of interest to the participants, with a mean of 2.4 and 3.3. Based on this result, it can be said that the participants had the lowest mean score for their interest in science communication. For example, item 7, which related to thinking about communicating general science concepts to students, received a low mean score compared to the other two items in this dimension.

Of the student responses to the items, the highest mean was found for item 6 and item 8. However, these mean scores are not high. These two items relate to interest in learning more and enjoyment in teaching students general science concepts.

Perceived Self-Efficacy in Science Communication

Table 3 shows that items regarding perceived self-efficacy had a mean of 2.1 and 3.4. 17 of 20 items regarding perceived self-efficacy received a mean score of less than three. Only the first three items in this dimension received a moderate mean score between 3.27 and 3.4.

Table 3. Participants' perceived self-efficacy in science communication

No	Items	M	SD
9	Understand middle and high school students' science background knowledge.	3.39	1.045
10	Understand middle and high school students' interest in science.	3.40	1.159
11	Understand middle and high school students' cognitive abilities.	3.27	1.007
12	Decide what science topics are appropriate for students.	2.81	1.151
13	Decide how much science content is appropriate for students.	2.69	1.163
14	Help teachers find relevant resources (e.g., science activities).	2.65	1.137
15	Develop science labs.	2.27	1.245
16	Develop out-of-school science learning activities.	2.27	1.244
17	Assist teachers in teaching lessons.	2.61	1.282
18	Assist teachers in conducting labs.	2.41	1.311
19	Teach science labs activities to students.	2.12	1.220
20	Facilitate out-of-school science learning.	2.22	1.213

Note. M: Mean & SD: Standard deviation

Table 3 (Continued). Participants' perceived self-efficacy in science communication

No	Items	M	SD
21	Lead small group activities/discussions with students in class.	2.35	1.271
22	Demonstrate scientific content, procedures, tools, or techniques to students.	2.30	1.312
23	Teach lessons or give lectures to students in class.	2.36	1.293
24	Explain a difficult science concept to students.	2.47	1.320
25	Relate current research to the K-12 curriculum.	2.46	1.360
26	Explain current research to teachers.	2.35	1.305
27	Facilitate student learning in museums.	2.19	1.204
28	Explain science to parents.	2.55	1.366
Total		2.55	.89

Note. M: Mean & SD: Standard deviation

Table 4. Results of t-test on effects of gender

	Gender	n	Mean	Standard deviation	df	t	p
Competence	Female	148	3.05	.89	224	-1.95	.051
	Male	78	3.29	.84			
Interest	Female	148	2.90	.97	224	-1.45	.147
	Male	78	3.10	1.01	224		
Perceived self-efficacy	Female	148	2.52	.80	224	-.59	.550
	Male	78	2.60	1.03			

However, these mean scores are not high. The highest mean was found for item 10. This item concerns understanding middle and high school students' interest in science. Based on this result, it can be concluded that the participants had more self-efficacy about understanding middle and high school students' interest in science. Another item with a high mean score is about understanding middle and high school students' science background knowledge. This result means that participants had more self-efficacy about understanding middle and high school students' science background knowledge. Regarding the understanding of students' cognitive abilities, it was found that the participants had a moderate mean score.

The lowest mean score was found for item 19, which refers to teaching science labs to students. Another lowest mean score was found in item 20 and item 27, which is related to facilitating out-of-school science learning and student learning in museums. Regarding the participants' perceived self-efficacy, it was found that they had the lowest average scores (<3.0 mean) when it came to indicating their self-efficacy in deciding appropriate science topics for students, determining the appropriate amount of science content for students, helping teachers find relevant resources (such as science activities), developing science labs, creating out-of-school science learning activities, assisting teachers in teaching lessons, assisting teachers in conducting labs, leading small group activities or discussions with students, demonstrating scientific content, procedures, tools, or techniques to students, teaching lessons or giving lectures to students, and explaining difficult science concepts to students or parents.

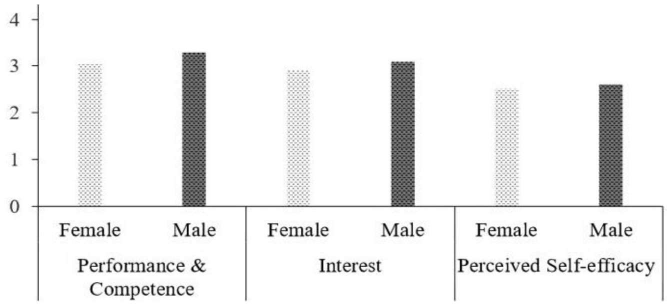

Figure 1. Participants' competence, interest, & perceived self-efficacy in science communication according to gender (Source: Authors' own elaboration)

Effects of Gender on Competence, Interest, & Perceived Self-Efficacy

To examine the differences between students' genders regarding their competence, interest, and perceived self-efficacy in science communication, their mean scores were compared using independent samples t-test to examine the effect of gender on students' mean scores.

The results of the t-test showed that there were no significant differences in terms of competence (t_{224}=-1.95, p>0.05) and interest ($t_{224=}$-.147, p>0.05) perceived self-efficacy ($t_{224=}$-.55, p>0.05) (**Table 4** & **Figure 1**). Because there were no significant differences in competence, interest, and perceived self-efficacy, the authors did not need to conduct post-hoc tests.

Effects of Grade Level on Competence, Interest, & Perceived Self-Efficacy

To examine the differences between students in different grade levels regarding their competence, interest, and perceived self-efficacy in science communication, their mean scores were compared using

Table 5. Results of one-way ANOVA on effects of grade levels

		Sum of squares	df	Mean square	F	Sig.
Competence	Between groups	6.764	4	1.691	2.207	.069
	Within groups	169.307	221	.766		
	Total	176.071	225			
Interest	Between groups	13.768	4	3.442	3.653	.007
	Within groups	208.258	221	.942		
	Total	222.026	225			
Perceived self-efficacy	Between groups	3.272	4	.818	1.030	.393
	Within groups	175.483	221	.794		
	Total	178.755	225			

the one-way ANOVA test to examine the effect of grade level on students' mean scores.

The results in **Table 5** showed that there were no significant differences in terms of competence ($F[4-221]=2.20$, $p>0.05$) and perceived self-efficacy ($F[4-221]=1.03$, $p>0.05$). Based on the test results, the calculated effect size was small for both competence as $\eta^2=.038$ and $\eta^2=.018$ for perceived self-efficacy in science communication.

On the other hand, the one-way ANOVA test results showed significant differences in students' interests between grade levels. For example, the mean score of the 1st grade students was 2.90, while the mean score of the 2nd grade students was 2.94. The mean score of 3rd grade students was 2.66, while the mean score of 4th grade students was 3.46. The mean score of master's students was 3.38. The statistical results revealed significant differences between students' interests and grade levels ($F[4-221]=3.65$, $p<0.05$). These differences were found between grades three and four and master students. These differences were favored in grade four students compared to 3rd grade and master students. The differences between 3rd grade and master students were in favor of master students. In addition, based on the test results, the calculated effect size was small for both competence as $\eta^2=.062$ for interests in science communication.

Results on Correlation Among Competence, Interest, & Perceived Self-Efficacy

Pearson correlation analysis investigated the correlation among competence, interest, and perceived self-efficacy in science communication. As given in **Table 6**, the results showed significant correlations among competence, interest, and perceived self-efficacy. Significant correlations were found between competence-interest ($r=.420$, $p<0.001$), competence-perceived self-efficacy ($r=.448$, $p<0.001$), and interest-perceived self-efficacy ($r=.472$, $p<0.001$). These correlations were moderate in magnitude. These results suggest that competence, interest, and perceived self-efficacy were linked.

Table 6. Correlations among competence, interest, & perceived self-efficacy

	1	2	3
Competence	-		
Interest	.420**	-	
Perceived self-efficacy	.448**	.472**	-

DISCUSSION

Competence in science communication is important for STEM graduates. Instruction for scientific communication at the undergraduate level should be considered an essential component for the future of STEM education. STEM students play a vital role in shaping the future of science communication. This study assessed undergraduate students' competencies, interests, and self-efficacy in science communication. The results showed that the participants' competence and interest in science communication were moderate. In addition, their perceived self-efficacies had low mean scores. These data show that STEM students do not believe they can engage in science communication, are not interested in it, and do not have adequate self-efficacy.

Specifically, participants had a mean score ranging from 3.0 to 3.5 for four items on competence in science communication. Only one item had a lower mean than the 3.0 mean score. These results show that participants' competence in science communication is not high. The lowest mean was found for the 5th item, which refers to asking for help from other participants in communicating general science concepts to students. This result is not comparable to that of Ritchie et al. (2022), who found that competence levels had good mean scores indicating high baseline levels for both. Ritchie et al. (2022) showed that STEM graduate students can effectively engage in scientific communication activities. Findings of Ritchie et al. (2022) showed that STEM graduate students had a notable level of proficiency in science communication, as evidenced by their self-confidence statistics. These results suggest that the participants in the study possess a strong belief in their capacity to effectively engage with general public in communicating scientific concepts. Approximately 50.0% of the participants indicated engaging in conversations with general public over general science themes, a marginally larger proportion than the 49.0% who reported discussing their dissertation. This finding implies that participants are equally inclined to discuss their ideas as they converse about general science topics. Twenty-five percent of participants indicated they did not perceive themselves as sufficiently equipped to discuss research topics beyond their expertise.

The results regarding the participants revealed that undergraduate students' interests ranged from a mean score between 2.4 and 3.3. This showed that participants had the lowest mean score for their interest in science communication. This is not comparable to that of Ritchie et al. (2022), who found that competence levels had good mean scores indicating high baseline levels for both. The data presented in this study indicate that graduate students in STEM disciplines had a notable interest in participation in science communication activities. Results regarding perceived self-efficacy showed that participants had mean scores between 2.1 and 3.4. The results revealed that 17 of 20 items regarding perceived self-efficacy received a mean score of less than 3.0. This result demonstrates that participants did not have adequate self-efficacy about science communication.

The results regarding students' genders regarding competence, interest, and perceived self-efficacy revealed no significant differences in competence, interest, or perceived self-efficacy. The findings of Ritchie et al. (2022) align partially with this conclusion, as they also found no statistically significant difference between genders in competence scores. However, they did identify a statistically significant distinction in interest levels for science communication. On the other hand, the results regarding students' grade levels revealed only a few significant results on the effects of grade level on their interests in science communication. These differences were favored in grade four students compared to 3rd grade and master students. The calculated effect size was small for both competence and perceived self-efficacy in science communication. These effects may be commented that grade level might increase students' interest in science communication topics.

The results regarding the lowest self-efficacy in science communication may stem from a need for more experience in discussing the facts about science with students or people. This idea is supported by the findings of (Leone & French, 2022). They found that undergraduate students' science identity and science communication self-efficacy considerably increased after participating in a research experience as part of a course. They indicated that, during their studies, students might rely on discussions with peers and professors to develop their scientific identities. These conversations about science and research can contribute significantly to forming their scholarly identities. Additionally, working in teams on research projects may provide a social-professional pathway for students, where their scholarly identity can develop over a prolonged period. From this perspective, it is important to provide an opportunity to develop their competence, interest, and self-efficacies in science communication over their undergraduate and graduate teaching periods. Leone and French (2022) also revealed that undergraduate students had a higher self-efficacy in science communication after having experience teaching STEM subjects in the course. Based on this detail, a reason for students' lowest mean scores regarding their competence, interest, and self-efficacies in science communication may stem from their lack of experience during their university teaching STEM subjects to transmit them to the students and the public.

Similarly, these statements are supported by evidence from Ritchie et al.'s (2022) research. They found a significant difference in performance and competence between individuals with prior teaching experience and those without. This difference was found to be statistically significant with a moderate effect size. The study also highlighted that women participants were more inclined towards science communication. In addition, those with prior teaching experience demonstrated a higher average score for competence than those without teaching experience. The finding supports the findings of previous research. A study conducted by Alderfer et al. (2023) showed that a workshop focusing on inclusive science communication for undergraduate students enhanced students' science and science communication identities and their science and science communication self-efficacy. Furthermore, a study by Murphy and Kelp (2023) confirms the significance of expertise in science communication. Their findings indicated that while STEM students are willing to partake in community involvement activities, they frequently encounter a dearth of possibilities. Furthermore, they discovered that the academic year did not influence the students' views and behaviors toward community engagement. Hence, offering informal science communication activities for undergraduate students is essential.

CONCLUSIONS

The study's data provides valuable information regarding STEM students' competence, interest, and self-efficacy in science communication training. These findings can be used as a basis for creating future science communication training programs that institutions explicitly offer. Due to the importance of STEM, it is essential to gather input from graduate students regarding their experiences in scientific communication education, their participation in the science communication process, and their competence, interest, and self-efficacy in the future of science communication education. University administrators and other educational stakeholders must carefully examine the information presented in this study while creating science communication education programs. These findings will assist in creating fair initiatives that maximize the potential benefits for all stakeholders involved.

RECOMMENDATIONS

The authors of this study did not explicitly inquire about the students' self-perception as either experts or novices in the field of science communication. Hence, it is essential to acknowledge the areas of competency, interest, and self-efficacy that should be considered for future research endeavors concerning the explicit self-identification of STEM students majoring in science as science communicators. Comparisons between individuals with expertise and those lacking expertise serve as significant research instruments due to their ability to offer practical insights into strategies for facilitating the development of novice individuals toward acquiring expert-like skills. A deeper understanding of the continuum between proficient and inexperienced science communicators may help improve science communication pedagogy.

Including science communication training and opportunities inside undergraduate courses will effectively address and surmount the obstacles associated with teaching science communication skills. It will increase the development of STEM major students' competency, interest, and self-efficacy. This research suggests various viewpoints for teaching science communication at universities regarding practice and experience. This highlights the importance of incorporating science communication within the official curriculum for university students. The first suggestion is to incorporate training inside the curricula of university students. Modifying undergraduate courses for incorporating and teaching science communication into the university curricula is suggested by the authors of this paper. The presented results in this research suggest a potential strategy that could effectively address university science communication teaching. From this perspective, increasing the quality of science communication training presented or given at universities is important to encourage undergraduate students to cultivate as science literate persons. Specifically, our results indicate that colleges and universities ought to offer training in science communication, support students in cultivating their self-efficacy in science communication and facilitate chances for undergraduate students in STEM fields to participate in science and public engagement activities.

LIMITATIONS

The authors of this study used quantitative data collection instruments to examine participants' competencies, interests, and self-efficacies in science communication. The results presented in this research are based on participants' self-assessments. However, this approach may have been limiting, so future scholars are encouraged to consider mixed-method data collection instruments for science communication research. Another limitation was related to the participants themselves. STEM major undergraduate students were involved in the research in a public research university in a single country. Future studies should aim to include more participants in their research. The present study's aims were also limited in scope, so future studies should focus on examining the effects of science communication courses or programs on undergraduate students competence, interest, and self-efficacy. It is worth noting that instruction that provides opportunities for students to engage in science practices without specific science communication instruction does not hinder their development of science communication competencies, interests, and self-efficacy. Hence, it is essential for future research to explore the progression of science communication skills, interests, and self-efficacy in both traditional face-to-face settings and online learning environments. This research should specifically focus on science communication instruction and compare the outcomes with those obtained without specific instruction to identify noteworthy disparities. Furthermore, it is recommended that future research endeavors do a comparative analysis of students' reported acquisition of skills between a hybrid instructional model and a traditional face-to-face format. Finally, there is also a research opportunity to measure the impact of background and contextual factors that may influence student competence, interest, and self-efficacy.

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