SCIENCE TALK IN THE SOUTHEAST: INVESTIGATING UNDERGRADUATES INTERPERSONAL SCIENCE COMMUNICATION VALUE AND SELF-EFFICACY.

Subject/Problem

Effective science communication is critical for bridging the gap between science and society to inform public opinion, political policy, and social change[1–3]. It has been identified as an important skill for STEM students by multiple reports and organizations across science disciplines[4–6]. Despite this prioritization, the majority of science communication trainings exist as upper-level elective courses, extracurricular programs, or graduate-level courses[2,7,8] that focus on communication between scientists or public presentations to broad audiences. However, undergraduate students report frequently engaging in *interpersonal* science communication about *culturally controversial science topics* (CCSTs)[9–11]*,* which are topics about which there is scientific consensus, but public disagreement, such as the causes of climate change or the safety of vaccines. These topics are highly relevant to both biology content and to students' lives, however, little is known about the extent to which undergraduate students value interpersonal science communication about these topics and if they feel confident engaging in them.

Because the diversity of undergraduate students exceeds that of scientists[12], these students may have a unique opportunity to serve as boundary spanners to their religious or political communities. Boundary spanners are individuals who can effectively bridge two communities with which they share identities (e.g. a Christian scientist talking to their religious community about evolution)[13]. Undergraduate students may have a strong capacity to serve as boundary spanners to religious and political communities with which scientists have historically been ineffective.

The southeastern United States may represent an area of particular interest for research on interpersonal science communication about CCSTs. The region has high rates of political conservativism[14] and religious affiliation[15,16] and low rates of vaccination[17], acceptance of anthropogenic climate change[18], and evolution[19]. As a result, students may face increased opportunities to engage in interpersonal science communication about these topics with people who do not agree with the scientific consensus.

In this study, we sought to answer the following research questions:
1) To what extent do undergraduate biology students in the southeastern United States feel value and self-efficacy for interpersonal science communication about CCSTs?
2) How does undergraduate value and self-efficacy for interpersonal science communication about CCSTs vary based on major, religion, and political affiliation?

Research Design

Survey Development

We conducted a literature review to identify existing instruments evaluating value and self-efficacy for science communication and revised existing items to be specific to interpersonal communication and culturally controversial science topics, as well as generating new items to address underrepresented areas. Instrument items were revised following expert review by biology education and science communication experts. Survey items asked students to rate their agreement with various statements about interpersonal science communication about culturally controversial science topics using a 5-pooint Likert agreement scale. We also collected demographic information including gender, race/ethnicity, religion, political affiliation, and major.

Recruitment

In the fall of 2024, we recruited instructors teaching 25 biology courses of more than 15 students at a Ph.D. granting, research-intensive university in the southeastern United States. These instructors distributed our survey to a total of 1,657 undergraduate biology students with the offer of a small amount of extra credit for participation, and we received a total of 867 complete responses (response rate = 52.3%). A summary of participant demographics can be found in Table 1.

Table 1: Participant demographics for survey participants (n = 867)

Gender	Political Affiliation	Religion	Race/Ethnicity
Man: 24.9% Woman: 71.9% Nonbinary: 1.6% Other: 0.2% Decline to State: 1.4%	Conservative: 26.0% Moderate: 22.8% Liberal: 31.8% Decline to State: 19.4%	Christian: 57.4% Non-Christian Religion: 10.0% Non-Religious: 25.7% Other: 1.5% Decline to State: 5.4% *Non-Christian Religion includes Buddhist, Hindu, Jewish, and Muslim students.	Asian: 14.2% PEER: 22.4% White: 53.4% Multiracial: 6.7% Other: 1.0% Decline to State: 2.3% *PEER includes Black, Native American, Pacific Islander, and
Major Biology: 44.7% Non-Biology: 54.1% Decline to State: 1.2%	**First-Gen Status** First Gen: 37.6% Non First-Gen: 59.6% Decline to State: 2.8%		

Analyses

All statistical analyses were conducted using R v. 4.4.1[20].

Table 2. Constructs of value and self-efficacy related to interpersonal science communication about culturally controversial science topics (CCSTs) among undergraduate biology students as determined by exploratory factor analysis. Students responded to survey items on a 5-point Likert agreement scale from Strongly Disagree to Strongly Agree.

Construct	Definition	Example Items
Value		
Cost	Perceptions of challenges or negative impacts of communicating.	"People would perceive me negatively if I engaged in conversations about culturally controversial science topics."
Desire to Improve	Perceptions of value or worth in improving their communication skills.	"I would be interested in improving my ability to communicate with others about culturally controversial science topics."
Intrinsic Value	Enjoyment or interest in communication.	"I enjoy engaging in conversations about culturally controversial topics in science."
Career Value	Utility of communication skills for their professional goals.	"In order to be good at the kinds of jobs I want to pursue, I must be skilled at having conversations about culturally controversial science topics."
Normative Value	Perceptions that others value communication.	"My peers value conversations about culturally controversial science topics."
Self-Efficacy		
External Validation	Efficacy students gain from external feedback about their communication.	"I have been told that I am effective at communicating about culturally controversial science topics."
Task Ease	Efficacy as reflected by the perceived difficulty of engaging in communication.	"Talking with people about culturally controversial science topics is challenging for me."
Potential for Impact	Efficacy gained from their belief that they have potential for impact.	"I can make a difference in the world with my skill in science communication about culturally controversial topics."
Emotional Control	Efficacy gained from students' physiological or emotional reactions (i.e. stress, anxiety) during communication.	"I have become frustrated when I have tried to talk with someone about a culturally controversial science topic."

Exploratory Factor Analysis: To evaluate how instrument items grouped into constructs, we conducted exploratory factor analysis using the R package EFAtools[21]. Our analysis resulted in five final factors for value and four final factors for self-efficacy. (Table 2).

Communication Value and Self-Efficacy: To evaluate students' value and self-efficacy, as well as how these factors were shaped by demographic variables, we used linear models and linear mixed-effects models for each construct, with the inclusion of course as a random effect where it was indicated by Kish's design effect. For each demographic variable that was identified as significant in our models, we calculated estimated marginal means of the slope of the relationship between each construct and the demographic variable and used pairwise comparisons with a Tukey adjustment for multiple comparisons to identify significant differences.

Findings

Overall Value and Self-Efficacy

Overall, students scored slightly above the midpoint of 3.0 on all constructs of value, with the exception of perceived costs, where students scored slightly lower (mean = 2.51). This indicates that students may not perceive significant costs but also do not necessarily see significant benefits of interpersonal science communication to their career, interests, or others in their lives. The pattern was similar for self-efficacy, with students scoring slightly above the midpoint of 3.0 for all constructs. The two constructs with the highest overall scores were Desire to Improve and Potential for Impact respectively, indicating that students may want to get better at science communication and could see the potential benefits of these skills for their communities.

Biology Majors vs. Non-Biology Majors

Biology majors reported significantly higher scores on the value constructs of Desire to Improve, Career Value, and Normative Value. This indicates that these students may see more potential for these skills to support their future career paths, may perceive others in their lives (teachers, classmates, etc.) as valuing these skills, and want to get better at navigating these conversations more than their non-major peers. Because of the importance of science communication skills to students in the sciences, these results indicate that current educational approaches may be benefiting biology majors. However, this may indicate a need to specifically emphasize the importance of effective science communication in non-majors' courses. These students will go on into careers in fields outside of the sciences and may have an important role in communicating about science that they learned in college biology courses with other non-experts.

Biology majors also reported higher self-efficacy in the construct of Potential for Impact. This indicates that these students may see a greater capacity to improve lives in their communities using their science communication skills. Strategies like socioscientific issues-based education may further increase students' confidence in their abilities to make change in their communities, and using similar pedagogical approaches in non-majors classes may help support these students as well.

Political Affiliation and Religion

Politically liberal students scored significantly higher than conservative students on all constructs of value except Cost, and also scored higher on the self-efficacy construct of Potential for Impact. This indicates that students who identify as politically conservative may not see clear benefits to engaging in conversations about CCSTs with others and may not perceive that others in their lives value these conversations. This represents an opportunity to increase value in all our students, and especially our politically conservative students, because of their potential to serve as boundary spanners to their political community. Conservative students may be able to more effectively communicate about these topics given their shared political identity, but must value the skill and feel confident engaging.

Politically conservative students scored significantly higher on the self-efficacy construct of Emotional Control, which may indicate a unique strength of these students. We may be able to support our students in learning from each other in how to effectively navigate emotionally difficult conversations about CCSTs through course-based practice opportunities.

While we anticipated that religious affiliation would have a significant impact on students' perceptions of science communication, we found no significant differences between religious groups. We also showed through mediation analysis that any differences that were present were mediated by differences in political affiliation across religious groups, indicating that communication about these topics may be more related to political identity than other key demographic traits. This also emphasizes the need for instruction that is politically culturally competent in addition to religious cultural competence.

Contribution

We determined that students in biology courses may not see the value in engaging in interpersonal science communication about CCSTs, especially those who were non-biology majors or politically conservative. This indicates the need for instruction targeted at illustrating the benefits of effective interpersonal science communication and the transferability of communication skills, as well as highlighting the potential for students to serve as boundary spanners with their communities. We also identified that students may not currently feel capable of succeeding in these conversations, which highlights the need for more educational and practice opportunities focused on interpersonal science communication targeted at undergraduate students. By identifying the needs of students, we can support the development of curriculum specifically targeted at addressing these needs. Additionally, we developed an instrument for this work that may be used to evaluate the impact of curricula and instructional practices on students.

General Interest

Facilitating trust between science and society is a core objective of science communication, and this goal aligns with the interests of NABT members. As educators, it is critical that we understand how to best prepare our students to communicate impactfully about controversial science topics, and understanding students' current perspectives is a key step. We have demonstrated that specific groups of students may have different needs in science communication education and have highlighted an overall need to demonstrate the value of science communication to our students and provide them with opportunities to build skills and gain confidence in their abilities.

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