Introduction

Science communication—sharing specialized knowledge or research outcomes with people outside academia (Burns et al., 2003)—is needed to help the public evaluate science-related topics, weigh risks and benefits, and make informed decisions (Treise & Weigold, 2022). Recent events and scientific advancements (e.g., COVID-19 pandemic, genome editing, artificial intelligence) have highlighted the rise and harm of scientific misinformation, which threatens public health and well-being (Calice et al., 2022; Galdames et al., 2024; Goldstein et al., 2021; Kisa & Kisa, 2024). When scientists fail to communicate effectively, misinformation often fills the void, with dangerous consequences for public understanding and policy (Scheufele & Krause, 2019; Vraga & Bode, 2020). Conversely, when scientists actively engage in science communication, they can build trust, counter misinformation, and help society navigate complex scientific issues (Besley, 2015; Fischhoff & Scheufele, 2013). Thus, scientists have both a professional responsibility and societal obligation to communicate their scientific knowledge beyond academic circles (Nisbet & Scheufele, 2009). However, despite this critical need, many universities lack the capacity to support science communication, creating a gap between societal needs and academic priorities (Dudo & Besley, 2016; Selin et al., 2016). Therefore, efforts to increase faculty engagement in science communication are essential (Nisbet & Scheufele, 2009; Trench & Bucchi, 2010).

Despite growing attention to science communication and its central role in the land-grant mission of sharing research with the public, barriers still discourage scientists from participating. These barriers include scientists not viewing public engagement as an institutional responsibility, inadequate training, and the lack of formal reward structures (Dunwoody & Ryan, 1985; Koswatta et al., 2022; Parrella et al., 2022). More recent research suggests that structural, cultural, and psychological barriers persist (Koswatta et al., 2022; Lewis Jr. & Wai, 2021; Medin & Bang, 2014; Nisbet & Scheufele, 2009).

Structurally, academia rewards research publications and grants over science communication, disincentivizing faculty from engaging with non-academic audiences (Jensen & Holliman, 2016; Rose et al., 2020). This reward structure is fundamentally misaligned with universities' public mission and the growing societal expectation that publicly funded research be accessible and understandable to taxpayers (Brownell et al., 2013). Culturally, some disciplines view science communication as secondary to scientific rigor, a perception known as the "Sagan Effect," named after Carl Sagan, whose nomination to the National Academy of Sciences was rejected due to his extensive time in the public spotlight (Mahoney, 1976; Martínez-Conde, 2016). This example reflects a broader cultural hesitation within academia where science communication and public engagement can be viewed as detracting from scientific credibility and productivity (Calice et al., 2022). Since then, the National Academies of Sciences, Engineering, and Medicine (NASEM) has shifted toward a more supportive stance on science communication, exemplified by its 2017 report *Communicating Science Effectively: A Research Agenda*, underscoring the importance of science communication as a professional competency requirement for all scientists (NASEM, 2017).

Even with this national shift toward valuing science communication, psychological factors—including anxiety about misrepresentation, lack of time, and insufficient training—continue to deter engagement (Davies, 2008; Baram-Tsabari & Lewenstein, 2017). These structural, cultural, and psychological influences are typically framed as barriers rather than as dynamic elements shaping scientists' professional identities. The lack of research on the dynamic process of science communicator identity (SCI; i.e., how one thinks about themselves as a science communicator; Baram-Tsabari & Lewenstein, 2017) calls for a more integrative theoretical lens that captures SCI as a negotiation of institutional, relational, and personal forces. Understanding how scientists develop SCI is essential for creating academic cultures in which science communication is normalized as part of scientific practice and identities (Dudo & Besley, 2016).

Identity—one's sense of self—influences responses to the social world and precedes actions (Alfrey et al., 2023; Ickes, et al., 2012). It determines how individuals give meaning to their roles, influencing their actions and the significance of their engagement (Stets et al., 2000). Scientists often have a well-developed science identity, referring to their self-identification as a scientist (Carlone & Johnson, 2007). In a review of 56 studies, Jiang and Wei (2023) identified social and cultural factors (e.g., meaningful peer interactions), contextual factors (e.g., learning environment climate), and personal factors (e.g., altruistic goals) as key components of science identity. While science identity has been widely studied (e.g., Hernandez et al., 2025), SCI has received little attention. As science communication evolves, scholars increasingly call for framing it not only as a skillset but as an integral part of academic identity (Baram-Tsabari & Lewenstein, 2017; Joubert et al., 2019). This shift recognizes that for science communication to become embedded in academic practice, it must be internalized as part of who scientists are, not just what they occasionally do (Davies & Horst, 2016).

According to the science communication learning goals model, SCI characteristics include confidence, viewing science communication as fundamental to being a scientist, and being perceived by others as a science communicator (Baram-Tsabari & Lewenstein, 2017). If scientists learn to communicate effectively, they can establish this identity (Baram-Tsabari & Lewenstein, 2017; Parrella et al., 2022). Evidence shows that communication training not only improves scientists' confidence in engaging with non-academic audiences but also strengthens their sense of responsibility (Besley et al., 2018). Early-career scientists socialized in academic environments that value science communication are more likely to develop a SCI (Dudo & Besley, 2016). Cultivating SCI among faculty could ensure that the next generation of scientists views science communication as a core professional responsibility rather than an optional activity (Parrella et al., 2022).

While recent scholarship has acknowledged identity as a factor in science communication, the recognition often lacks depth and theoretical rigor (Baram-Tsabari & Lewenstein, 2017; Davies & Horst, 2016). For example, some studies reference the concept of identity in science communication obliquely and use it descriptively without explicitly connecting it to a theoretical framework or examining the roles of different identity dimensions (Baram-Tsabari & Lewenstein, 2017). Comprehensive investigations are needed to understand how scientists perceive and define their SCIs. Such inquiry is essential for understanding barriers and enablers to engagement and for creating support structures and institutional cultures that sustain it. Investigating science communication through an identity lens could help foster a culture of engagement within scientific communities by informing interventions that support scientists' development as communicators. This study addresses that gap by examining the enacted, personal, relational, and communal identity frames shaping SCI among university scientists.

Theoretical Framework

The study is grounded in the communication theory of identity (CTI), a framework from social psychology and communication studies that we applied to understand how university scientists develop their identities in the context of science communication (Hecht et al., 1993). Drawing on identity theory, CTI explains how identity is shaped and expressed through communication (Shin & Hecht, 2017). It views identity as both an internal sense of self and something constructed and performed through interaction with others (Hecht, 1993;

Hecht et al., 1993, 2003). CTI asserts that "social relations and roles are internalized by individuals as identities through communication" (Jung & Hecht, 2004, p. 266). Individuals enact identities through social behaviors, which are also shaped by identities formed in prior interactions. Because science and communication are embedded in social relationships, CTI recognizes multiple levels of identity beyond the individual self. It identifies four identity frames: personal, relational, enacted, and communal (Hecht, 1993; Hecht et al., 1993, 2003; Jung & Hecht, 2004).

Personal identity is one's self-concept; the introspective aspect of identity that shapes responses to socially ascribed roles and expectations. It develops through meaning-making of lived experiences, external ascriptions, and social feedback (Hecht et al., 1993, 2003; Jung & Hecht, 2004). This frame captures internal self-evaluations and beliefs people hold about themselves. CTI does not explicitly state that psychological constructs such as self-efficacy—beliefs about one's capability to perform a task (Anderson et al., 2016)—are part of a personal identity. However, in the current study, we measured self-efficacy as a component of personal identity because it is a form of internal self-perception (Alam et al., 2023; Bandura, 1997; Bong & Clark, 1999). Thus, we included it alongside other internal cognitions such as motivation, perceived responsibility, and confidence in science communication.

Enacted identity, in contrast, is visible, performative, and communicative. It is expressed through behaviors, communicative practices, and interaction patterns. It is situationally dependent on context, purpose, or audience, making it a co-constructed aspect of identity (Hecht, 1993; Hecht et al., 1993, 2003; Jung & Hecht, 2004). Relational identity is co-constructed through interpersonal relationships and centers on individuals' perceptions of themselves in relation to others within specific relationships. It emerges through communicated role expectations, shared meanings, and mutual recognitions. Communal identity is constructed at the group level, developing through identification with broader social groups, like professional communities, and involving shared belonging, narratives, and values (Hecht, 1993; Hecht et al., 1993, 2003; Jung & Hecht, 2004).

Though individuals may not express all four identity frames simultaneously, they co-exist and dynamically influence each other (Jung & Hecht, 2004). CTI thus offers a valuable framework to examine SCI's complexity and multidimensionality. While CTI has been applied in some communication contexts, such as health communication (e.g., Hecht & Choi, 2012), intercultural communication (e.g., Hecht et al., 1993, 2003), and education (e.g., Orbe, 2004), it has not, to our knowledge, been studied in science communication. Previous studies have explored factors influencing scientists' engagement (e.g., Rodrigues et al., 2023; Rose et al., 2020; Wilkinson et al., 2023), but none have examined how different CTI identity frames influence SCI development. This study investigates how factors associated with CTI frames influence university scientists' SCI. Three research questions guided the study:

1. What are the characteristics of faculty members' engagement in science communication, including the types of activities, their motivations, the audiences they engaged with, and their perceived barriers?
2. What influence do perceived responsibility to communicate, confidence in science communication skills, perceived public interest, mentors' science communication practices, and expectations of others have on SCI?
3. How do enacted, personal, relational, and communal identity frames interact to influence SCI?

Methods

Context of Study

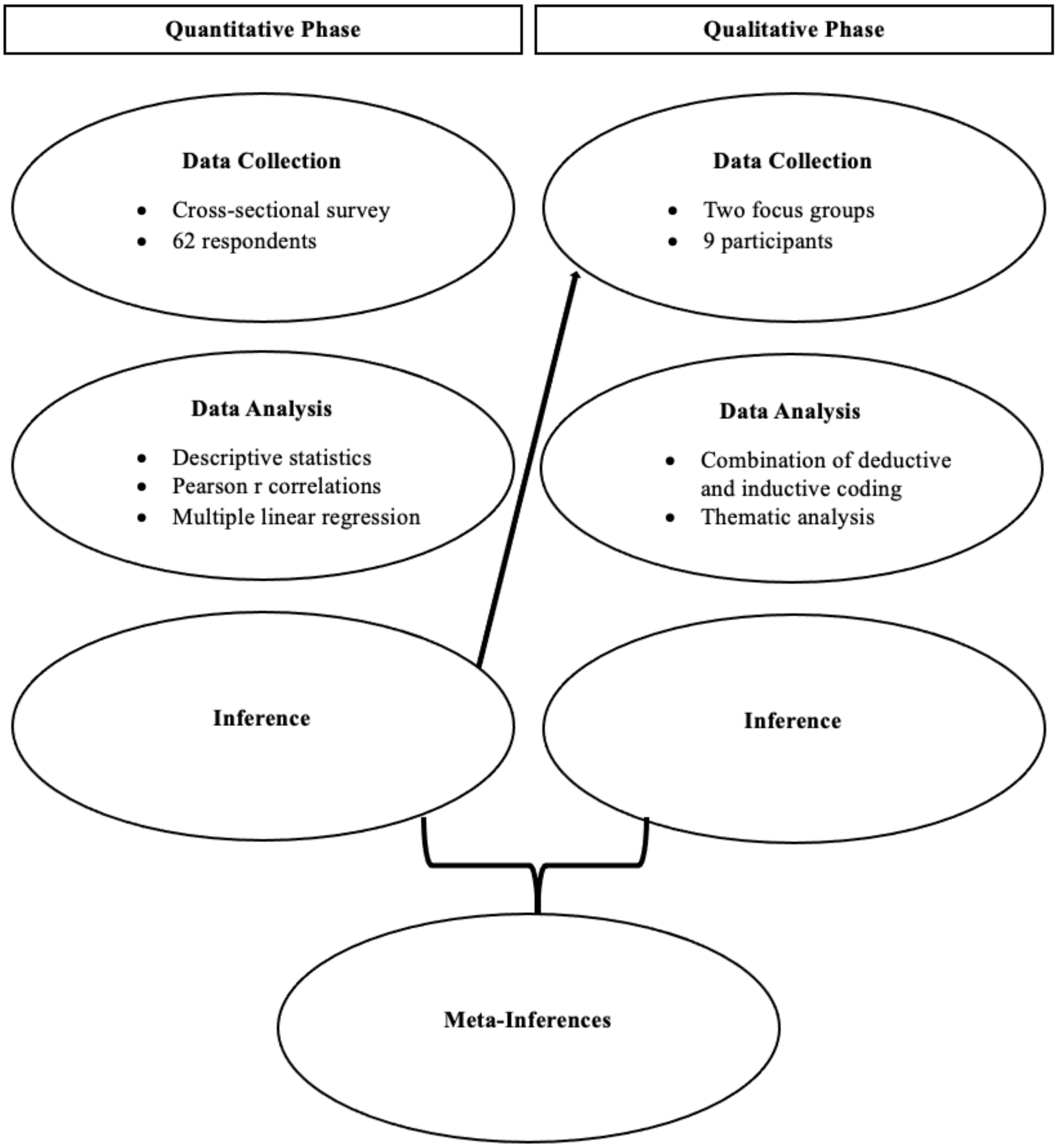
The current study was supported by internal seed funding from the Virginia Tech Center for Advanced Innovation in Agriculture (CAIA), the Virginia Tech Institute for Creativity, Arts, and Technology, and the Virginia Tech Applied Research Corporation. These entities share a mission to foster interdisciplinary innovation, applied research, and public impact—much of which is in agricultural and life sciences contexts. We chose to focus on faculty in agricultural and life sciences because the research team is actively involved in advancing science communication in these fields, and the funding entities have strong connections to agricultural innovation and outreach. It is important to note, however, that focus group participants in phase two were recruited from a pool of faculty who had received seed grants from CAIA within the past two years. As a result, two participants were from colleges outside of CALS, and one was from Virginia State University as a member of a project team led by Virginia Tech.

Research Design

We employed a sequential-explanatory mixed-methods research design (see Figure 1). Such a design allows for the collection of both quantitative and qualitative data, ensuring that each data collection phase supports the other (Creswell, 2013; Creswell & Plano Clark, 2018). In the current study, the quantitative survey data (phase one) served as the basis for generating focus group questions (phase two; Creswell & Plano Clark, 2018). Additionally, qualitative focus group data collected during phase two played a supporting role by contextualizing and enriching the quantitative cross-sectional survey data collected during phase one, while also generating new knowledge not captured in the quantitative data alone (Creswell, 2013; Creswell et al., 2003; Stange, 2006). Both data collection phases enhanced our understanding of the enacted, personal, relational, and communal factors influencing scientists' SCI.

Figure 1

Representation of the Sequential Explanatory Mixed-Methods Research Design



Phase 1: Cross-Sectional Quantitative Survey

Instrument Development

We developed a cross-sectional survey instrument to measure multiple variables at a single point in time (Connelley, 2016). Guided by CTI, we included variables aligned with the four identity frames—enacted, personal, relational, and communal. Although the concept of SCI is relatively new, we drew on relevant identity and science communication research (e.g., studies of STEM identity, motivations to communicate science; Besley et al., 2018; Rose et al., 2020; Wilkinson et al., 2023).

The dependent variable was SCI. We adapted the descriptive aspect of Hiller's (2005) leader identity scale to measure SCI using four items on a 5-point Likert scale: 1) I am a science communicator; 2) I see myself as a science communicator; 3) If I had to describe myself to others, I would include the phrase “science communicator”; and 4) I prefer being seen by others as a science communicator. We also asked respondents whether they considered themselves a science communicator (“Yes” or “No”).

Enacted Identity. Enacted identity variables included engagement in science communication, frequency of engagement, types of science communication activities, and participation in training. We assessed engagement by asking whether respondents had engaged in science communication with people outside of academia in the past three years (“Yes” or “No”; Koswatta et al., 2022). To assess frequency, we asked how frequently respondents engaged in science communication with people outside of academia, using the response options “Never,” “Less than yearly,” “Yearly,” “Quarterly,” “Monthly,” and “Weekly or more frequently” (Koswatta et al., 2022). To assess types of engagement within the past three years, respondents selected from 20 science communication activities (see Results; Koswatta et al., 2022; Rodrigues et al., 2023; Rose et al., 2020). We assessed training engagement by asking whether respondents had participated in formal science communication training in the past three years (“Yes” or “No”; Koswatta et al., 2022).

According to CTI’s conceptualization of personal identity as an individuals’ internal self-understandings (Hecht et al., 1993, 2003), we operationalized the personal identity frame as respondents’ internal beliefs and self-appraisals regarding science communication. Therefore, personal identity variables included motivations for engagement, science communication self-efficacy, perceived responsibility, and confidence in science communication skills. To assess motivations, respondents rated 14 statements on a 5-point Likert scale, adapted from Rodrigues et al. (2023), Wilkinson et al. (2023), Koswatta et al. (2022), Alderfer et al. (2023), Murphy and Kelp (2023), and Martin-Sempere et al. (2008; see Results). We measured science communication self-efficacy with four researcher-developed items on a 5-point Likert scale: 1) I feel confident when communicating about science with people outside of academia; 2) I can effectively convey scientific information in various settings; 3) I feel capable of managing any challenges that arise during science communication; and 4) I am confident in my ability to engage and connect with audiences when discussing science.

We measured perceived responsibility to communicate science by asking participants to rate three researcher-developed items on a 5-point Likert scale: 1) I feel responsible for making my research accessible to people outside of academia; 2) I have a moral duty to engage with people outside of academia about my research; and 3) It is important for me to actively seek opportunities to communicate my research to people outside of academia. To measure confidence, we asked how confident they felt performing six science communication tasks using a 5-point Likert-type scale from *Not at all confident* to *Extremely confident*. These tasks, adapted from Rodrigues et al. (2023) and Koswatta et al. (2022), were: 1) Simplifying complex scientific concepts; 2) Engaging in two-way communication; 3) Using narrative techniques to convey science information; 4) Establishing personal connections with an audience based on shared values; 5) Adapting messages to suit different audience needs; and 6) Using visual aids (e.g., graphs, charts, infographics).

Relational Identity. Relational identity variables included primary audiences engaged with, science communication practices of mentors, perceived expectations of others, and perceived public interest. To assess primary audiences, respondents selected from 13 audiences they engaged with in the past three years (see Results; Rodrigues et al., 2023). We measured science communication practices of mentors with four researcher-developed items on a 5-point Likert scale: 1) I observe(d) my science mentor(s) engage in science communication; 2) My science mentor(s) model(ed) effective science communication practices; 3) My science mentor(s) actively participate(d) in science communication; and 4) My science mentor(s) taught me what I know about science communication. We measured perceived expectations of others with four researcher-developed items on a 5-point Likert scale: 1) My colleagues believe I should engage in science communication; 2) My department/school encourages faculty to participate in science communication activities; 3) Scientists in my field expect each other to engage in science communication; and 4) My professional community values science communication. We measured perceived public interest with three researcher-developed items on a 5-point Likert scale: 1) People are interested in my specialized knowledge/research outcomes; 2) There is a demand from people for information about my specialized knowledge/research outcomes; and 3) People are eager to learn about my specialized knowledge/research outcomes.

Communal Identity. Communal identity variables included barriers to engaging in science communication, perceived importance of science communication to others, and perceived institutional support. To assess barriers, respondents rated 14 statements on a 5-point Likert scale, adapted from Wilkinson et al. (2023), Varvayanis et al. (2023), Rodrigues et al. (2023), Parrella et al. (2022), and Koswatta et al. (2022) (see Results). We measured perceived importance to others by asking respondents how important they perceived science communication was to six entities using a 5-point Likert scale: 1) You; 2) Your colleagues; 3) Your department chair/director; 4) Your college dean; 5) Virginia Tech; and 6) Virginia residents. Finally, we measured perceived institutional support with three researcher-developed items on a 5-point Likert scale: 1) High-level administrators at Virginia Tech prioritize science communication as an institutional goal; 2) Scientists at Virginia Tech who engage in science communication are well regarded by their peers; and 3) Scientists at Virginia Tech receive recognition for their science communication efforts.

Data Collection

We collected survey data via QuestionPro in January–February 2025 by sending one email to the college faculty listserv and two emails to department heads, requesting they forward the survey to faculty. We obtained 65 usable responses. The listserv includes approximately 800 addresses, some of which belong to staff who were not part of the intended faculty population. Based on this distribution, the approximate response rate is 8.1%, though the actual rate for the target faculty population is likely higher.

The first survey page included study information, Institutional Review Board approval (#24-939; October 1, 2024), and informed consent. Respondents who consented proceeded to a definition of science communication: “For the purpose of this survey, science communication refers to the process of sharing specialized knowledge or research outcomes with people outside of academia. Therefore, it does not include interactions with other scientists or classroom teaching.”

Sample

As noted previously, Phase 1 survey respondents were all from CALS, while Phase 2 focus group participants were CAIA seed grant recipients, including three faculty from other colleges. The survey sample was almost evenly split by gender, with 50.88% (*f*=29) of respondents identifying as male and 45.61% (*f*=26) identifying as female (see Table 1). In terms of ethnicity, the majority identified as white or European (86.21%, *f*=50).

Table 1

Demographic Characteristics of Survey Respondents

Characteristic	*f*	%
Gender (*n*=57)		
Male	29	50.88
Female	26	45.61
Prefer not to respond	3	3.51
Ethnicity (*n*=58)		
Asian or Asian American	2	3.45
Black or African American	1	1.72
Hispanic, Latino/a/x, or Chicano/a/x	3	5.17
White or European	50	86.21
Biracial or multiracial	1	1.71
Prefer not to respond	1	1.71

Respondents represented all nine units in CALS, which includes both departments and schools, and various faculty roles (see Table 2). The majority (70%, *f*=42) had 11 or more years of experience and did not hold an administrative appointment (72.41%, *f*=42).

Table 2

Career Characteristics of Survey Respondents

Characteristic	*f*	%
Department/School (*n*=60)		
Agricultural and Applied Economics	4	6.67
Agricultural, Leadership, and Community Education	9	15.00
Biochemistry	6	10.00
Biological Systems Engineering	3	5.00
Entomology	10	16.67
Food Science and Technology	5	8.33
Human Nutrition, Foods, and Exercise	4	6.67
School of Animal Sciences	5	8.33
School of Plant and Environmental Sciences	14	23.33
Years of experience in academic field (excluding graduate school) (*n*=60)		
Less than one year	3	5.00
1–5 years	7	11.67
6–10 years	8	13.33
11–20 years	19	31.67
More than 20 years	23	38.33
Faculty role (*n*=59)		
Adjunct professor	1	1.69
Administrative and professional faculty	4	6.78
Assistant professor	7	11.86
Associate professor	8	13.56
Professor	14	23.73
Collegiate assistant professor	2	3.39
Associate extension specialist	5	8.47

Characteristic	*f*	%
Extension agent	2	3.39
Extension specialist	3	5.08
Senior extension specialist	1	1.69
Instructor	2	3.39
Lecturer	2	3.39
Postdoctoral associate	1	1.69
Research assistant professor	2	3.39
Research associate	2	3.39
Research scientist	2	3.39
Senior research scientist	1	1.69
Administrative appointment (*n*=58)		
No	42	72.41
Yes	16	27.59

Data Analysis

We retained all survey responses and handled missing data using pairwise deletion, excluding responses only from analyses where values were missing. For all analyses, we used Stata v 18.0. To answer the first research question, we conducted a descriptive analysis. To answer the second research question, we conducted a simultaneous multiple linear regression analysis using ordinary least squares as the estimation method. We excluded science communication engagement, frequency of engagement, and past training experience in the model due to insufficient responses in each category. Thus, the model included no predictors aligned with the *enacted* CTI frame.

The initial model included self-efficacy (personal); perceived responsibility (personal); confidence in skills (personal); science communication practices of mentors (relational); perceived expectations of others (relational); perceived public interest (relational); perceived importance to others (communal); and perceived institutional support (communal). However, the number of predictors was too high given our sample size, so we relied on various criteria to determine which predictors to remove, including Variance Inflation Factors (VIF) values to assess multicollinearity. VIF values below 2.5 are considered acceptable, meaning they have less than 60% shared variance (Allison, 1999). Thus, we removed *perceived importance to others*, which had a VIF of 2.71. All remaining predictors had VIFs below 2.45 (mean VIF=2.05).

To further reduce the number of predictors and avoid multicollinearity, we examined Pearson *r* correlations and Cronbach's alpha coefficients. There were two correlations above *r*=.62 (excluding the dependent variable). We retained *confidence in skills* over *self-efficacy* (*r*=.69, *p*<.001) and *perceived importance to others over perceived responsibility (r*=.63, *p*<.001) to ensure that the final model included a variable from the communal CTI domain. We then removed *perceived institutional support*, which had a non-significant effect in each model iteration and the largest p-value. The final model met the recommended guideline of 10–15 observations per predictor (Green, 1991).

We assessed regression assumptions, including linearity, normality of residuals, and homoscedasticity. Lowess lines in the Residual vs. Predictor Plots were aligned with the linear reference line for most of the distribution, supporting linearity. Density and QQ Plots showed a close to normal distribution of residuals (skewness: -0.36, kurtosis: 3.61). The Residual vs. Fitted Plot presented a consistent dispersion of residuals, and the Breusch-Pagan test was non-significant ($X^2(1)=1.36$, *p*=.243), supporting homoscedasticity.

Phase 2: Qualitative Focus Groups

Protocol Development

The survey results guided development of the focus group protocol to further explore phase one results (see Table 3). We asked participants six questions to define SCI, describe factors contributing to SCI, identify perceived barriers, and react to survey results. Responses helped prompt further discussion.

Table 3

Focus Group Questions

Introductory Questions
1. How do you define science communicator identity? 2. What experiences or variables do you perceive as contributing to the development of science communicator identity? 3. What barriers do you perceive as hindering the development of a science communicator identity?
Survey Follow-Up Questions
1. Analysis of emergent research on science communicator identity has revealed a five variable of science communicator identity: responsibility to communicate science, confidence in science communication skills, perceived public interest in science, mentorship, and subjective norms. What are your reactions to these findings? 1a. How might you model the interaction of these variables? 2. What do you think contributed to the development of the five variables? 2a. How do you see them in your own experiences as a science communicator? 3. Emergent research also revealed the following as frequent barriers to the development of a science communicator identity: "Science communication is not part of my official duties;" "There are not enough financial rewards for science communication work;" and "I have not received adequate training in science communication." What are your reactions to these findings?

Data Collection

We conducted two focus groups on February 24 and 26, 2025. We recruited participants from a list of faculty who had received a seed grant from CAIA in the past two years. We sent two recruitment emails, one week apart, explaining the monetary incentive for participating. Interested faculty completed a brief application with their name, college, department, title, and a short description of their research. We sent a scheduling poll to identify convenient times. We recorded the focus groups and transcribed them verbatim.

Sample

Focus group participants were CAIA seed grant recipients. Nine faculty participated in the focus groups—six in one session and three in the other. We assigned pseudonyms to ensure confidentiality. Participants represented various career stages (see Table 4).

Table 4

Characteristics of Focus Group Participants

Pseudonym	University	Title
Ellis	Virginia Tech	Assistant Professor
Remy	Virginia Tech	Associate Professor
Noa	Virginia Tech	Senior Extension Specialist
Alex	Virginia Tech	Assistant Professor
Jordan	Virginia Tech	Assistant Professor and Extension Specialist
Taylor	Virginia State University	Professor
Cassey	Virginia Tech	Assistant Professor
Riley	Virginia Tech	Associate Professor and Extension Specialist
Quinn	Virginia Tech	Research Assistant Professor

Data Analysis

Two researchers analyzed the focus group data using both inductive and deductive approaches. We used in vivo coding with gerunds (Charmaz, 2014) to capture processes (e.g., barriers), actions (e.g., engagement), and meanings (e.g., self-efficacy), then used axial coding (Strauss & Corbin, 1998) to group codes into themes aligned with the four CTI identity frames. This deductive step helped explain survey results structured around CTI-aligned variables. We used an inductive approach to allow new findings to emerge. To ensure trustworthiness, we used peer debriefing, clarified our positionality, recorded an audit trail, and provided rich, thick descriptions (Creswell, 2013).

Limitations

This study has three primary limitations. First, the sample size was small, which limited the number of predictors included in the regression model and reduced statistical power. We excluded all variables related to the *enacted* CTI frame due to an insufficient number of responses per group, limiting the comprehensiveness of the identity model evaluated. Fortunately, the mixed-methods research design helped address this limitation by providing additional qualitative insights into how science communication engagement related to SCI. Second, survey respondents were primarily white and mostly research faculty within CALS, limiting the generalizability of results to a broader and more diverse faculty population. Third, because we recruited faculty to participate in research about science communication, it is possible that those who already viewed themselves as science communicators were more likely to participate. This potential selection bias may have increased the proportion of respondents with more developed SCI and should be considered when interpreting the findings.

Results

RQ1: Characteristics of Faculty Members’ Engagement in Science Communication

Of 65 respondents, 89.23% (f=58) considered themselves science communicators. Respondents were close to agreeing that they felt a sense of SCI (M=3.49, SD=0.84) and felt responsible to engage (M=3.83, SD=0.88; see Table 5). They also agreed that others expected them to (M=3.78, SD=0.72), that it was important to others (M=3.67, SD=0.84), and that the public was interested in their research (*M*=3.81, *SD*=0.78). Respondents felt very confident in their skills (*M*=3.69, *SD*=0.69) and self-efficacy (*M*=3.94, *SD*=0.60) but were neutral on whether their mentors engaged in science communication (*M*=3.33, *SD*=0.98).

Table 5

Means, Standard Deviations, and Internal Consistency of Variables

Variable	*n*	*M*	*SD*	α	CTI Domain
Perceived responsibility to engage	63	3.83	.88	.89	Personal
Confidence in science communication skills	62	3.69	.69	.85	Personal
Science communication self-efficacy	63	3.94	.60	.85	Personal
Science communication practices of mentors	62	3.33	.98	.94	Relational
Expectations of others	62	3.78	.72	.85	Relational
Perceived public interest	62	3.81	.78	.91	Communal
Perceived importance to others	62	3.67	.84	.90	Communal
Science communicator identity	65	3.49	.84	.84	--

Note. α = Cronbach's alpha coefficient. Scale: 1.00–1.49=strongly disagree/not at all confident/important; 1.50–2.49=disagree/slightly confident/important; 2.50–3.49=neither agree nor disagree/moderately confident/important, 3.50–4.49=agree/very confident/important; 4.50–5.00=strongly agree/extremely confident/important.

Enacted Identity

Of 63 respondents, 17.46% (*f*=11) had participated in formal science communication training in the past three years and 82.54% (*f*=52) had not. Of 65 respondents, 95.38% (*f*=62) had engaged in science communication with people outside of academia in the past three years, while 4.62% (*f*=3) had not. Among those who had engaged, 37.10% (*f*=23) did so weekly or more, 29.03% (*f*=18) monthly, 19.35% (*f*=12) quarterly, 11.29% (*f*=7) yearly, 1.61% (*f*=1) less than yearly, and 1 selected "other."

Most respondents engaged in a variety of science communication activities, with the most common being workshops or training sessions (77.42%, *f*=48), public talks or lectures (72.58%, *f*=45), and webinars or online panels (62.50%, *f*=39; see Table 6). The one "other" response described providing written reports on food safety regulations to clientele.

Table 6

Respondents' Science Communication Activities (N=62)

Science Communication Activity	*f*	%
Conducted workshops or training sessions	48	77.42
Delivered public talks or lectures (e.g., science cafés, community events)	45	72.58
Hosted or participated in webinars or online panels	39	62.90
Created or contributed to newsletters	36	58.06
Participated in public exhibitions or demonstrations	34	54.84
Responded to questions from the general public via email, letter, or telephone	33	53.23
Had meaningful conversations about my research in my personal communities, including family, friends, church, or other groups	30	48.39
Produced multimedia content (e.g., podcasts, videos, infographics)	30	48.39
Conducted science outreach programs for schools or youth groups	29	46.77

Science Communication Activity	*f*	%
Developed and distributed educational materials (e.g., brochures, fact sheets)	29	46.77
Appeared on media platforms (e.g., radio, television, social media) as a science expert	26	41.94
Managed social media accounts for science communication	24	38.71
Met with local, state, or federal policymakers	23	37.10
Listened to the concerns and enthusiasms about my research from the community	18	29.03
Engaged in public meetings or deliberative forums	17	27.42
Provided science communication training for other professionals	13	20.97
Wrote news articles, press releases, or opinion pieces	13	20.97
Managed a personal or institutional science communication website	10	16.13
Wrote for science magazines or other specialized publications	9	14.52
Led consultations or clarification sessions	8	12.90
Wrote blog posts	7	11.29
Created art or interactive exhibits for science communication	5	8.06
Other	1	1.61
None of these	0	0.00

Note. Respondents selected all that applied.

Personal Identity

Respondents were motivated to communicate science because they enjoyed it, with 90.32% (*f*=56) agreeing or strongly agreeing (see Table 7). Most also agreed or strongly agreed that they were motivated by their desire to educate others (85.48%, *f*=53), a sense of professional responsibility (88.71%, *f*=55), and their desire to counter misinformation (82.26%, *f*=51). Financial benefits were the least motivating factor.

Table 7

Respondents' Motivations for Engaging in Science Communication in the Past Three Years (N=62)

Motivation	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%
I enjoy engaging in science communication.	0	0.00	1	1.61	5	8.06	31	50.00	25	40.32
I am keen to educate others about science.	0	0.00	1	1.61	8	12.90	24	38.71	29	46.77
Engaging in science communication is required for my funded research.	5	8.06	12	19.35	13	20.97	16	25.81	16	25.81
My institution requires science communication.	4	6.45	10	16.13	13	20.97	21	33.87	14	22.58

Motivation	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
Engaging in science communication is my responsibility as a scientist.	1	1.61	2	3.23	4	6.45	28	45.16	27	43.55
Engaging in science communication enables me to attract research funding.	4	6.45	7	11.29	19	30.65	23	37.10	9	14.52
Engaging in science communication raises my profile as a researcher.	3	4.84	4	6.45	14	22.58	25	40.32	16	25.81
Engaging in science communication counts towards my career (e.g., professional memberships, promotion).	4	6.45	6	9.68	16	25.81	17	27.42	19	30.65
Engaging in science communication helps me build professional networks and connections.	2	3.23	2	3.23	11	17.74	29	46.77	18	29.03
I want to counter misinformation on science topics.	1	1.61	0	0.00	10	16.13	22	35.48	29	46.77
Engaging in science communication increases the profile of my institution.	1	1.61	0	0.00	9	14.52	26	41.94	26	41.94
Engaging in science communication fosters meaningful connections with my local community.	1	1.61	3	4.84	6	9.68	29	46.77	23	37.10
I am invited to communicate science.	0	0.00	6	9.68	9	14.52	26	41.94	21	33.87
I engage in science communication for financial benefits.	23	37.10	19	30.65	13	20.97	4	6.45	3	4.84

Relational Identity

Respondents most commonly engaged with local communities (78.33%, *f*=47), students beyond their classrooms (70%, *f*=42), and industry professionals (70%, *f*=42; see Table 8). Less common audiences included journalists (28.33%, *f*=23), social media followers (28.33%, *f*=23), and politicians (25.00%, *f*=15). One respondent selected "Other," specifying extension staff.

Table 8

Audiences With Which Respondents Engaged in Science Communication (N=60)

Group	*f*	%
Local communities (including community organizations and faith-based organizations)	47	78.33
Students (beyond your classroom)	42	70.00
Industry professionals	42	70.00
Farmers/Agricultural producers	38	63.33
Families	35	58.33
Businesses or companies	28	46.67
Non-governmental organizations	28	46.67
Youth groups	23	38.33
Journalists	23	28.33
Social media followers	23	28.33
Politicians	15	25.00
Other	1	1.67
None of these	1	1.67

Communal Identity

The most common barriers to engagement were limited financial rewards, the belief that science communication was not part of their official duties, and lack of adequate training, with 39.06% (*f*=25), 34.37% (*f*=22), and 31.75% (*f*=22) of respondents agreeing or strongly agreeing, respectively (see Table 9). Additionally, 29.68% (*f*=19) agreed or strongly agreed that they lacked time to engage, and 28.13% (*f*=18) agreed or strongly agreed that science communication takes time away from research. The least common barriers were interest in science communication and fear of public rejection, with 85.72% and 49.21% of respondents, respectively, disagreeing or strongly disagreeing.

Table 9

Barriers Respondents Encounter in Science Communication

Barrier	*n*	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
		f	%	*f*	%	*f*	%	*f*	%	*f*	%
My institution does not provide support for science communication.	64	10	15.62	24	37.50	19	29.69	9	14.06	2	3.12
Science communication is not part of my official duties.	64	15	23.44	19	29.69	8	12.50	13	20.31	9	14.06

Barrier	*n*	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
There are not enough financial rewards for science communication work.	64	8	12.50	7	10.94	24	37.50	18	28.12	7	10.94
It is challenging to find effective channels for reaching my target audience.	64	5	7.81	21	32.81	25	39.06	9	14.06	4	6.25
I do not have the time to engage in science communication.	64	10	15.62	21	32.81	14	21.88	18	28.12	1	1.56
Science communication takes time away from my research.	64	6	9.38	16	25.00	24	37.50	15	23.44	3	4.69
I lack confidence in my science communication skills.	64	11	17.19	32	50.00	15	23.44	3	4.69	3	4.69
I have not received adequate training in science communication.	63	5	7.94	24	38.10	14	22.22	16	25.40	4	6.35
I am not interested in science communication.	63	31	49.21	23	36.51	7	11.11	1	1.59	1	1.59
My area of expertise is not interesting to the public.	63	18	28.57	32	50.79	10	15.87	3	4.76	0	0.00
I fear that my science communication efforts might be rejected or not well received by the public.	63	11	17.46	20	31.75	16	25.40	12	19.05	4	6.35
I do not have opportunities to engage in science communication.	63	21	33.33	27	42.86	4	6.35	11	17.46	0	0.00
My peers have negative opinions about science communication.	63	17	26.98	29	46.03	13	20.63	3	4.76	1	1.59
Science communication is not valued in my discipline.	63	18	28.57	32	50.79	9	14.29	3	4.76	1	1.59

RQ2: Influence of CTI-related Variables on Faculty Members' SCI

Most variables were significantly correlated and showed moderate to substantial relationships (Davis, 1971; see Table 10). Confidence in science communication skills was moderately related to perceived importance to others (r=.44, p<.001) and perceived public interest in research outcomes (*r*=.37, *p*<.01). Science communicator identity was substantially correlated with expectations of others (*r*=.61, *p*<.001) and perceived importance to others (*r*=.63, *p*<.001).

Table 10

Pearson r Correlations Among Variables Included in the Regression Model (N=62)

	1	2	3	4	5	6
Perceived importance to others (1)	1					
Confidence in skills (2)	.44***	1				
Perceived public interest (3)	.55***	.37**	1			
Practices of mentors (4)	.38**	.14	.28*	1		
Expectations of others (5)	.62***	.27*	.54***	.38**	1	
Science communicator identity (6)	.63***	.44***	.32**	.33**	.61***	1

Note. *** indicates *p*<.001; ** indicates *p*<.01; * indicates *p*<.05. Variables relate to the CTI frames as follows: Perceived importance to others = communal; Confidence in skills = personal; Perceived public interest = relational; Practice of mentors = relational; Expectations of others = relational; Science communicator identity = dependent variable.

The regression model explained 53.55% of the variance in SCI (adjusted R^2=49.41%; see Table 11) and was statistically significant (*F*(5, 56)=12.91, *p*<.001). Each additional point in perceived importance to others is associated with an average increase in SCI of .362 (*t*(56)=2.74, *p*=.008); each additional point in confidence is associated with an average increase in SCI of .287 (*t*(56)=2.28, *p*=.026); and each additional point in expectations of others is associated with an average increase in SCI of .481 (*t*(56)=3.33, *p*=.002).

Table 11

Results from the Regression Model with Science Communicator Identity as the DV (N=62)

Predictors	Science Communicator Identity			
	B (S.E.)	*t*	*p*	*Β*
Intercept	-.038 (.535)	-.07	.944	--
Perceived importance to others	.362 (.132)	2.74	.008	.236
Confidence in skills	.287 (.126)	2.28	.026	.236
Perceived public interest	-.216 (.124)	-1.74	.088	-.202
Practices of mentors	.042 (.087)	.48	.634	.049
Expectations of others	.481 (.144)	3.33	.002	.412

Note. Predictors relate to the CTI frames as follows: Perceived importance to others = communal; Confidence in skills = personal; Perceived public interest = relational; Practice of mentors = relational; Expectations of others = relational; Science communicator identity = dependent variable.

RQ3: Interaction of CTI Frames on SCI

We grouped the codes from the focus group data into sub-themes and then categorized them under the four CTI frames. Three sub-themes aligned with the *personal* frame, and two sub-themes aligned with the *enacted*, *relational*, and *communal* frames (see Table 12). The results suggest that institutional structures and culture influence participants' science communication engagement by supporting or discouraging how they express their values, build relationships for skill building, and navigate communication challenges.

Table 12

Themes and Sub-Themes from the Thematic Analysis

CTI Frame	Sub-theme	Representative Experience
Communal Identity Frame	Practicing shared norms	"I would say I have a community of practice that is really focused on evaluation and reporting…"
	Perceiving institutional support	"…there is this bias of rewarding something that's more data driven and scientifically high impact factor journal…"
Personal Identity Frame	Acknowledging science communication responsibilities	"…having the responsibility is key because that makes me feel like, okay, I am obligated to communicate it better to the audience…"
	Feeling inadequate for science communication	"…so public speaking is something that I feel like I struggle with. It is my barrier…"
	Feeling motivated to communicate science	"I would say also my love for people and different cultures and the ability to travel and to a space that's unfamiliar…"
Relational Identity Frame	Learning science communication through relationships	"…if you like somebody else's way of talking or communicating, keep that in mind if you can include those…"
	Experiencing challenges communicating with audiences	"So people are looking for those black and white certain answers, and I don't have them, I think that's a barrier."
Enacted Identity Frame	Developing skills for science communication	"…and really trying hard to build up my ability to communicate in ways that different populations might understand…"
	Selecting communication strategy	"…they don't discriminate against all sorts of elements of human nature…so all of that you know we keep in mind when we are thinking about communication…"

Theme 1: Communal Identity Frame

The communal frame of identity reflected participants' perceptions of institutional support and shared norms related to science communication. Some felt a lack of institutional support, citing a lack of training opportunities, a lack of recognition, and the exclusion of science communication in formal job responsibilities. Remy shared, "We just don't receive much training in it…I think that's a barrier." Taylor emphasized that structural expectations often limit engagement beyond the academy, stating that some faculty "are not required to expose themselves to people who may not understand them." Participants also expressed concern that science communication is not rewarded. Riley explained, "Unfortunately, the outreach part is not rewarded monetarily…I see that as a big disappointment in the university system. Because it just tends to convey the wrong message that you are supposed to do one half of your job better than the other." As a result, participants prioritized activities that are more institutionally recognized. Several participants described science communication as a shared norm within their community of practice. Quinn said, "I have a community of practice that is really focused on evaluation and reporting…and how we can use our reporting to uplift community voices and partners…that's really contributed to my idea of how I see myself as communicating science."

Theme 2: Personal Identity Frame

The personal identity frame reflected participants' motivations, perceptions of responsibility, and emotional responses to science communication. Participants considered science communication a responsibility, either as a personal value or as part of their professional roles. Cassey said, "If we want to have science communicators, then we have to have folks who think it is their responsibility to communicate their findings." Remy, reflecting on his Extension role, added, "Working in extension… we are much more public facing and applied when it comes to what we do." For some, this responsibility stemmed from internal conviction; for others, it was externally imposed. Some participants also described fulfillment and enjoyment as motivations for engaging in science communication. Morgan shared, "[I] love being out, and I love being in the community," while Riley expressed his love for different people, cultures, and exploring new places. On the other hand, some participants expressed feelings of inadequacy in communicating science, citing concerns such as feeling like an imposter, discomfort with public speaking, and a lack of relevant skills.

Theme 3: Relational Identity Frame

The relational frame of identity reflected participants' experiences learning science communication through relationships and navigating challenges when communicating with audiences. Participants described learning science communication through giving and receiving mentorship, observing other science communicators, and receiving training. For example, Ellis shared, "Mentorship could potentially be a path for a future or current science communicator to feel more responsibility to build and feel more confident." Participants also identified audience-related challenges they experienced, including fears of being misunderstood, low confidence from the audience, lack of interest from the audience, and audience impatience. As Sarah noted, science communication can "draw positive attention, but it can also draw negative attention."

Theme 4: Enacted Identity Frame

The enacted frame of identity reflected participants' science communication skill development and the selection of communication strategies. Participants discussed building skills through frequent practice and learning from prior experiences in both science communication and broader life contexts. Reflection on these experiences helped them identify areas for growth. For example, Riley shared, "You kind of learn from your own mistakes where you can improve and get better every time." Participants emphasized the importance of expressing vulnerability, demonstrating empathy, aligning their work with public interests, and tailoring communication to their audience's preferred communication methods and level of scientific knowledge. As Alex explained, "Communicating the information in a way that makes it feel relevant, not intimidating, not dismissive, not patronizing."

Integrating the Survey and Focus Group Data

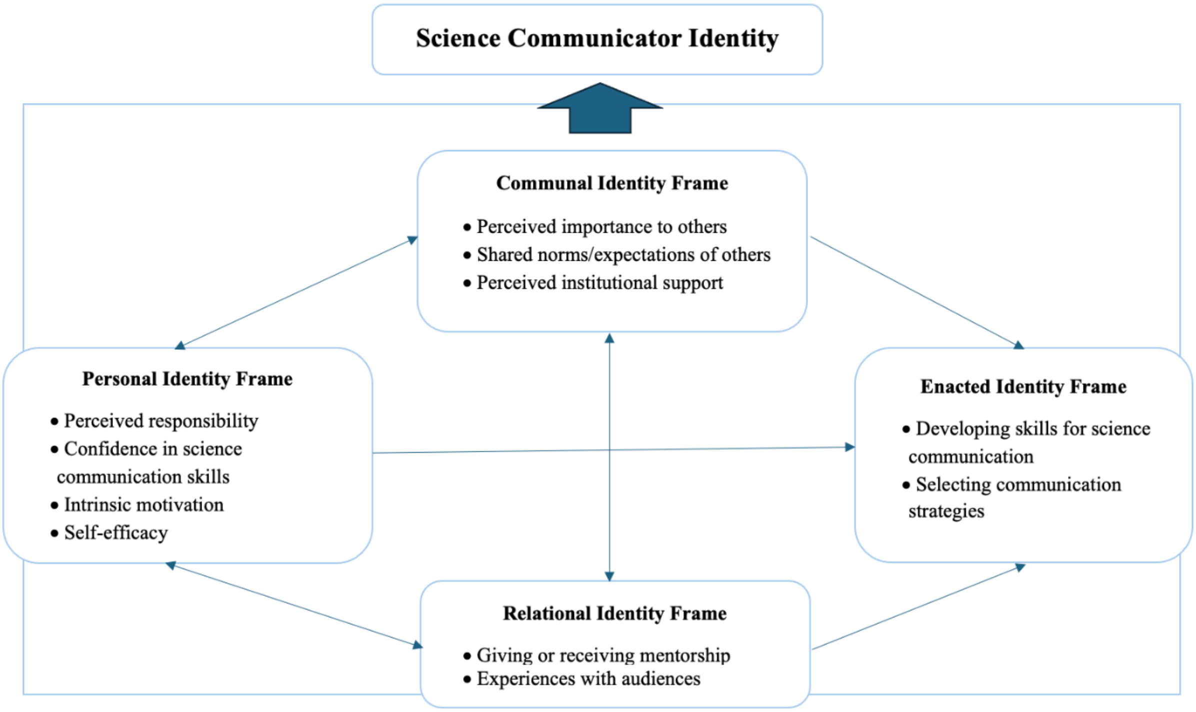
The integrated model illustrates how the four CTI frames contribute to SCI development (Jung & Hecht, 2004; see Figure 2). The personal identity frame reflects scientists' internal beliefs, including confidence in their science communication skills, self-efficacy, intrinsic motivation, and perceived responsibility. The communal identity frame, positioned at the center of the model, represents shared norms, social expectations, perceived importance to others, and institutional support. The enacted identity frame captures behavioral expressions of science communication, such as developing skills and selecting communication strategies. The relational identity frame reflects interactions with others, including mentorship (giving or receiving) and experiences with audiences.

The arrows in the model show how the identity frames interact. Scientists' confidence and motivation (personal) both influence and are influenced by social expectations and institutional support (communal). Communal identity also influences and is influenced by scientists' engagement with mentoring and audiences (relational). Personal and relational identity similarly influence each other bidirectionally. These personal, communal, and relational processes then influence scientists' science communication behaviors (enacted). SCI emerges from the dynamic interaction of all four frames.

We developed the model using both the quantitative and qualitative findings. Qualitative themes demonstrated how scientists described the interactions among the personal, relational, communal, and enacted identity frames. The quantitative regression analysis, which included SCI as the dependent variable, supported the directional influence of the personal, relational, and communal identity frames on SCI. In addition, statistically significant positive correlations among variables associated with these three frames informed our decision to depict their relationships as bidirectional in the model. The enacted identity frame and its connections are grounded solely in the qualitative findings because variables associated with enacted identity were not included in the quantitative analyses due to sample size and multicollinearity constraints.

Figure 2

Science Communicator Identity Model of Interacting Communication Theory of Identity Frames



Discussion

This study explored characteristics of university scientists' engagement in science communication and CTI-related variables influencing SCI. Participants engaged in science communication through public talks, workshops, webinars, and educational materials, reflecting their self-identification as science communicators. The results support prior research suggesting that identity precedes and is reinforced by behavior (Alfrey et al., 2023; Meltzer et al., 2020). They also affirm CTI's usefulness for understanding how multiple identity layers relate to scientists' communication practices (Hecht, 1993; Hecht et al., 1993, 2003).

Participants' engagement in science communication stemmed mainly from intrinsic motivations, including enjoyment, a desire to educate, professional responsibility, and countering misinformation. Fostering SCI is important because identity drive these motivations (Van der Werff et al., 2013). However, intrinsic motivation alone may not sustain engagement due to persistent barriers such as limited financial incentives, lack of time, and perceptions that science communication detracts from research. Qualitative findings further illuminated these challenges. Participants noted that institutional structures and promotion metrics hindered their ability to prioritize science communication, creating a "split in identities" between personal motivations and professional roles. This tension corroborates CTI's concept of identity interpenetration, in which different identity layers interact and influence each other (Jung & Hecht, 2004). It also reflects prior research on institutional barriers to science communication (Rodrigues et al., 2013; Wilkinson et al., 2023). Institutions that value science communication could address these issues by formally recognizing it in faculty roles, offering training, and providing structural support and incentives.

Regression results revealed that confidence in skills (personal identity), expectations of others (relational identity), and perceived importance to others (communal identity) significantly contribute to SCI, consistent with focus group findings. These findings extend prior research on self-efficacy, group membership, and group expectations in identity development to SCI (Brenner et al., 2018; Hogg & Terry, 2000; Korte, 2007; Miles & Naumann, 2021; Stets & Burke, 2000). The findings also reinforce CTI's value for explaining how SCI develops across intersecting identity domains. Scientists who feel confident, believe science communication matters to others, and perceive expectations to engage are more likely to embody a SCI.

Interestingly, regression results showed that mentors' science communication practices and perceived public interest did not significantly predict SCI, despite moderate correlations. Participants felt neutral about whether their mentors engaged in science communication, suggesting inconsistent modeling of these behaviors. Focus group participants were surprised that mentor practices were not significant, highlighting a potential gap in professional development. Early-career scientists may lack science communication role models. Future research should examine how intentional mentorship supports the development of SCI.

This study is the first theoretically grounded investigation of SCI, the first application of CTI in a science communication context, and the first proposed model depicting how identity layers interact to shape how scientists see themselves as science communicators. Future research is needed to continue building and testing this framework. For example, studies could explore whether SCI predicts engagement, shedding light on identity as a driver of behavior. Additional research should investigate how variables associated with the enacted CTI frame (e.g., frequency, type of activities) contribute to SCI, and other identity frames, using quantitative methods. Quantitative research could also examine whether communal identity moderates the influence of personal and relational identity on enacted identity. Finally, longitudinal research would help us understand how SCI develops over time, and experimental research could examine how SCI changes in response to targeted interventions, such as science communication training or shifts in institutional support.

Although the findings may not generalize beyond the sample of CALS faculty at Virginia Tech, they offer insights that could be useful for enhancing the SCI of faculty at other universities. First, job descriptions and contracts should explicitly include science communication responsibilities. Second, institutions can foster SCI through visible support, such as grants and recognition in promotion structures (Schwetje et al., 2020; Trench & Miller, 2012). Third, science communication training can strengthen scientists' confidence, a central component of SCI (Swords et al., 2023). Together, these strategies may promote science communication engagement by reinforcing identity-based motivation among faculty.

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