IMAGININGSoTL

# Tightrope Walking: Balancing Leadership Roles and Partnerships with Undergraduate Student Assistants in SoTL Research

Carolyn Bjartveit and Simran Kandola, Mount Royal University, Canada

## ABSTRACT

In this reflective essay, a researcher relates her experience of supporting partnerships with undergraduate student research assistants (RAs) during a SoTL study. Unexpected changes to the ethics requirements after the study had received approval and commenced resulted in changing the leadership roles of the research team members and adjusting procedures for facilitating interviews with the study participants. Although unsettling at the time, these modifications opened valuable opportunities for the RAs to co-facilitate focus group interviews and hone their leadership and research skills. Reflections on the researcher's and a student RA's experiences exemplify the SoTL principles of "respect, reciprocity, and shared responsibility" in supporting student partnerships (Cook-Sather et al., 2014, p. 27). Expanding further by recognizing rights as a principle promotes equal faculty-student research partnerships and acknowledges the knowledge, professional experience, and leadership skills that undergraduate student RAs contribute to SoTL studies and project work.

*Keywords:* faculty-student partnerships, rights-based research practice, the Scholarship of Teaching and Learning, student leadership, undergraduate student research assistants

DOI: https://doi.org/10.29173/isotl876

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

> *Wire and I together… I walk on air that softens under each step. I glide each foot. I cut through the whitish lump of breeze with the knife of my balancing pole. I walk on the air like a funambulist.*
>
> — Philippe Petit, The Routledge Circus Studies Reader, 2016

Balancing on a tightrope. This image first came to mind as I (Carolyn) reflected on my partnership with student research assistants (RAs) in a recent scholarship of teaching and learning (SoTL) research study.[1] Over the past two years the research team, composed of two undergraduate student RAs and a faculty researcher, explored the educational experiences of immigrant students and their sense of belonging in an undergraduate post-secondary degree program at a mid-sized university in western Canada. Prior to working on the study, the student RAs completed a research methodology course and the TCPS 2 Core Course on Research Ethics (Government of Canada, 2022). As the principal investigator, one of my key research objectives was to invite student participants from diverse cultural backgrounds to discuss their cultural protocols and views on teaching and learning with faculty instructors, including the barriers that they faced in the classroom due to cultural differences. It is important to note that this essay is not about the research study findings, but on limitations of the study due to research ethics requirements added after the project had commenced. Adherence to the modifications resulted in changes to the leadership roles of research team members and to the procedures for conducting the participant focus group interviews. Although the situation was in no way death threatening, as walking on a tightrope suspended high above the ground can be, the emotions felt by the study participants and research team members were real—like a tightrope walker might experience when the cord sways beneath their feet.

The term "funambulist" is defined as a "tightrope walker, coined from *funambule* (1690s) [and] from Latin *funambulus*, the classical name for a performer of this ancient type of public entertainment" (etymonline, n.d.). Exercising metaphorical thinking and creating a metaphor about tightrope walking offered a critical lens through which to view and understand the successes, challenges, and tensions that the research team faced. In reference to the use of metaphor, philosopher Hans-Georg Gadamer (2004) explained that the "transference from one sphere to another not only has a logical function; it corresponds to the fundamental metaphoricity of language" (p. 429). Thus, metaphor is a valuable way of coming to understand through figurative language. Yeo and Woolmer (2022) have noted that metaphor "illustrates the complexity of the experience of ethics in SoTL. It

[1] This research study received ethics approval from the Human Research and Ethics Board at Mount Royal University on June 14, 2023. Application #103498: "Exploring Immigrant Students' Partnership With Faculty to Increase Cultural Awareness and Inclusion in the Bachelor of Child Studies Degree Program."

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

breaks open and reframes … existing assumptions about our roles as teacher and researchers and our relationships with our students, leading us to think of them anew" (p. 31). I envision my roles as researcher, educator, and mentor to student RAs as three ropes twisted together to create the metaphorical cord upon which I walk. Like a tightrope walker treading carefully within a liminal space, I am ever conscious of my research activities and cognizant that uncalculated steps could potentially cause harm. Despite the challenges and altered research procedures, the ethics modifications opened opportunities for the student RAs to adopt leadership roles and hone their research and leadership competencies—opportunities that they would not otherwise have had. In a later section of this paper, a student research assistant, Simran Kandola, with whom I worked, shares her insights as both a research partner and leader; all remaining sections were authored by me.

While recognizing that a tightrope walking metaphor is extreme in relation to our research, the determination of skillful funambulists to reach their goals and continue practicing their highwire artform regardless of obstacles points to hope and relates to our research team's experience and motivation to fulfill the research objectives even in the face of challenges. The metaphor provoked me to explore stories of daring funambulists like Nik Wallenda, who took risks, managed unexpected changes in plans, weather, and equipment, and, despite all, successfully walked between the United States and Canada atop a highwire over Niagara Falls ("Nik Wallenda," 2012). I am drawn to the experiences of Philippe Petit, who in 1974 walked across a cord strung forty thousand feet above the ground, between the twin towers of the World Trade Centre in New York City. Petit is also a poet and writer. Layering quotes from his tightrope walk together with my own imagined tightrope experience and Simran's reflections points to the importance of "respect, reciprocity, and shared responsibility" (Cook-Sather et al., 2014, p. 27) in supporting student partnerships and recognizes students' right to exercise agency and adopt leadership roles in SoTL research. Expanding on Cook-Sather et al.'s (2014) principles for "engaging students as partners in teaching and learning" (p. 16) by including rights as a fourth principle is a key focus in this paper and is exemplified through Simran's explanation of her research experiences.

The next section provides a review of scholarly works, including a layering of Felten and Lambert's (2020) ideas about "relationship-rich education," the SoTL principle of "partnership with students" (Felten, 2013; Cook-Sather et al. 2014), and student leadership (Simmons & Taylor, 2019). This creates a conceptual lens through which to view and understand our recent research experiences. The sections following the literature review include an account of my research experiences as the principal investigator and Simran's reflection on her partnerships and leadership role in the study, in which she was a student RA. I conclude the article by reflecting on faculty-student partnerships and the relevant implications for student RAs' leadership development as well as rights-based approaches to SoTL research, teaching, and learning.

Keynote and session speakers at the SoTL symposium sessions in Banff, Alberta, in 2024, emphasized that challenges in research can potentially yield

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

valuable learning opportunities. The research team discussed the study findings and our "tightrope walking" experiences with participants who attended our roundtable session at the symposium. Their perspectives led us to write this reflection paper. By sharing our experiences, we aim to elevate the image of undergraduate student RAs as capable leaders, thereby raising awareness and advocating for their right to participate as equal partners in SoTL research projects.

## STUDENTS AS PARTNERS IN SOTL RESEARCH: A SCHOLARLY REVIEW AND CONCEPTUAL FRAMEWORK

A review of SoTL research literature spanning the past decade reflects an increasing focus on empowering and engaging students in faculty-student collaborations on co-inquiry projects and teaching and learning activities in post-secondary education settings (Allin, 2014; Bovill et al., 2011; Cook-Sather et al., 2016; Healey et al., 2014; Matthews & Dollinger, 2023; Werder et al., 2012). Healey et al. (2014) describe a faculty-student partnership as "a sophisticated and effective approach to student engagement because it offers the potential for a more authentic engagement with the nature of learning itself and the possibility for genuinely transformative learning experiences for all of those involved" (p. 55).

Felten's (2013) fourth principle of good SoTL practice, emphasizes "partnership with students" (p. 123). This partnership must be built on a foundation of mutual respect. In Cook-Sather et al. (2014), respect is understood as an attitude that values the contributions of others; reciprocity involves two-way interactions and an exchange of perspectives between partners; and responsibility recognizes students and faculty as equal collaborators and supporters of learning (pp. 28–30). These partnerships are "dialogic, in which the learning and teaching are co-conceptualized and co-created between equal partners" (Webb, 2020, p. 12). Mercer-Mapstone et al. (2017) have also explained that collaborations between students and faculty provide opportunities for students to engage as active and equal contributors to teaching and learning. The students' roles as co-researchers and co-designers of research are facilitated through creating a sense of community and trust built on the shared values of student and faculty partners (Healey et al., 2014). Felten's (2013) notion of "students as partners" layered with Cook-Sather et al.'s (2014) principles of "respect, reciprocity, and shared responsibility" provide a conceptual framework for understanding our student-faculty partnership and can be expanded to include the rights of student RAs to participate as equal collaborators in SoTL research.

The tenets of human research ethics prioritize protecting and respecting the rights of study participants involved in SoTL research. Advocating for the rights and protection of student RAs also requires consistent monitoring during a research study. The power differential between faculty researchers and the students they hire might compel students to continue in their assistant role despite unexpected factors that create potential risks and concern them. Similar to how researchers honour the right of participants to withdraw from studies (as outlined in research consent forms), student RAs should also understand their right to withdraw from research

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

and partnerships without repercussions of any kind. Fedoruk (2022) has explained how ethics is currently being addressed in SoTL studies, stating that "questions, complexities, and challenges surrounding ethical ways to conduct research on teaching and learning continue to emerge" (p. xiii). Navigating the ethics modifications for our study served as a catalyst for developing the RAs' leadership skills and strengthening partnerships with their research team members.

Field et al. (2021) have described partnerships in relation to "supervisory relationships" between graduate students and faculty with potential for collegiality. Richards and Fletcher (2020) refer to "critical friendship" with the potential for faculty relinquishing control in their research collaborations with students. My ideas align with Lock et al.'s (2021), who, in reference to graduate-level students, make a compelling case for equitable partnerships with faculty built on trust and opportunities for student RAs to exercise agency in designing, implementing, and disseminating SoTL research. They also explain how traditional assistants' roles are limited in influencing the planning and direction of projects and emphasize how more equal partnerships between faculty and graduate students are beneficial to both the collaborators and to research outputs (Lock at al., 2021). While conducting a search of academic literature, I noted that research and scholarly works related to partnerships between faculty and undergraduate student RAs is limited. This gap raises critical questions about how undergraduate students' research skills, capabilities, and contributions are recognized within the academy. My hope is that this paper will initiate conversations among academic researchers, scholars, and educators about the roles and rights of student RAs to participate as research partners in undergraduate academic settings and contribute to SoTL literature about teaching and learning.

## A Tightrope Walking Experience: Carolyn's Reflections

*Inundated with astonishment, with sudden and extreme fear, yes; with great joy and pride, I hold myself in balance on the high wire.*

— Philippe Petit, *The Routledge Circus Studies Reader*, 2016

The purpose of our research study was to explore immigrant students' educational experiences and sense of belonging, both to increase cultural awareness and inclusion within the university. After receiving ethics approval to proceed with the study, I invited immigrant students enrolled in an undergraduate Child Studies degree program to participate in an information meeting and two focus group interviews. The research process included an initial conversation with the student participants to provide information about the study. Students would then share their cultural views and the barriers impacting their learning and decide what information they wished to share with faculty instructors. In a second focus group interview, the student participants met with faculty instructors and shared their cultural perspectives and recommendations for increasing inclusion in classroom settings. Finally, the students and faculty participants met with the research team in two

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

separate focus groups to discuss the learning outcomes from the prior student-faculty conversation and respond to the research questions.

After the participants were recruited and the first planning meeting was scheduled, I was informed by the ethics board that my participation in the student focus groups created a conflict of interest due to a possibility that I might teach the students during the four years of the cohort degree program. I was advised not to attend the student interviews and therefore asked a third-party faculty member to collect the students' signed consent forms and participate in the student focus group interviews in my place. I was permitted to analyze the interview transcriptions only after they had been anonymized. I was grateful for the help of a faculty colleague who volunteered to step in and participate in the student focus group interviews. The student RAs volunteered to facilitate the student focus group interviews with the assistance of the faculty partner. I was impressed with the students' confidence and motivation to facilitate the interviews and considered how peer-to-peer student discussions might also help the student participants feel more comfortable about openly sharing their education experiences.

The first student participant meeting was well attended, and the RAs noted the engagement and lively discussions of the students and their willingness to share their cultural perspectives, educational experiences, and sense of belonging within the university. However, when faculty participants joined students in the next focus group meeting, some tensions arose. The student participants' attendance was low and those who did attend were unable to respond to some of the faculty members' questions regarding classroom experiences and the barriers that students who were not present at the meeting had previously faced. My absence from the meeting and inability to respond to the questions that the RAs were unable to answer created stress for student and faculty participants alike as well as members of the research team. Engaging in rescue and repair was not what I had anticipated when I embarked on the research journey. Alarmed by what had transpired and concerned for all involved in the student-faculty focus group interview, I was forced to retrace and rethink each step of the planning and implementation of the study. Although the ethics board had approved the research design, data collection tools, and procedures, I doubted my decision to allow the student RAs to co-facilitate the student-faculty focus group. Cognizant that a third-party faculty member was present to support the RAs in my absence, I wondered if I had placed too big of a responsibility on the students by agreeing to their request to facilitate the interview. After reflecting, I came to recognize how I was doubting the RAs' abilities to manage unexpected circumstances and to function effectively. The SoTL principles of "respect, reciprocity, and shared responsibility" took on new meaning and importance in relation to sustaining relationships between research partners. This is exemplified in the next section by Simran's story and experiences, including the positive and negative impacts on her partnerships and leadership development.

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

## THE ROLE OF STUDENT PARTNERSHIP AND LEADERSHIP: SIMRAN'S REFLECTIONS

To prepare for the first student information meeting, my RA partner and I developed an online presentation to help guide our facilitation. I was excited and nervous going into the first meeting as this was the first time I was in a facilitation role in an online format. I felt well prepared to have discussions with the participants about their experiences. There were many students present and, as the conversation continued, the participants felt comfortable sharing their classroom experiences. This was a moment for me to apply my learning from the classroom and degree program. At the end of the student meeting, we (the RAs) invited the participants to discuss recommendations to share with faculty at the next interview, including specific practices for increasing cultural awareness and inclusion in the classroom. We reassured the student participants that both RAs and a faculty research partner would be present during the student-faculty focus group interview.

Based on the first student meeting, I learned that I needed to focus on my pace as a facilitator, to ensure there would be time to ask the research questions and for discussion as the participants were eager to share their experiences. As a facilitator, I wanted to ensure that everyone had a chance to speak, and that all the participants' voices were heard. Encouraging participation was a leadership skill that I learned through facilitating the student meeting. We structured our focus group to flow so that each participant had an opportunity to share, and I left that meeting feeling accomplished and confident in my ability to facilitate and lead.

The second focus group interview included both faculty and student participants. To prepare for the meeting, we created an online presentation that followed a similar format to the student focus group interview. I remember feeling very anxious about this meeting, as faculty members would be involved, and I had never facilitated or presented in front of faculty members outside of class assignments. To aid my presentation anxiety, I did multiple practice runs through the meeting with my RA peer to gain familiarity with the flow of the presentation. When the focus group interview started, most faculty participants were present and few student participants. The small number of student participants was completely unexpected; we had planned for an equal number of faculty and student participants. During the interview, the faculty participants asked questions about points in the presentation, made by student participants who had attended the previous meeting. However, the students who had made these points were not present to respond to their questions. At that moment, I felt unsure about how to move forward. I remembered the student focus group meeting and had witnessed the participants openly and confidently sharing their experiences with us. I did not think that it was appropriate for me to comment on their classroom and learning experiences in their absence and provide context because these were not my experiences to share—these were *their* student experiences, and this would have

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

been their opportunity to share with the faculty.

When you are participating in a research study, participants have the right to withdraw consent at any point. I wondered if the students who chose not to participate may have decided to withdraw from the study or were anxious about meeting and sharing their ideas and experiences with faculty. I needed to take a step back from the discussion and calm myself as I was thinking about how to move forward. This is when a specific thought ran through my brain: "We are going to make sense of this together." My RA partner referred to the transcripts from our first student participant meeting to provide context and information for the faculty. This led to further discussions between the faculty and student participants about the points those students had shared about their cultures and classroom experiences. We then started to make progress and move forward in a positive way.

At the end of the meeting, we checked in with our faculty partner and Carolyn. For me, this was the most critical part of my journey. This helped me transform all the "firsts" I had experienced throughout this research study into leadership learning opportunities, such as co-facilitating with my research partner, actively listening, building trust, and encouraging participation from students and faculty in the focus groups. I remember leaving the meeting feeling discouraged about my leadership skills. Having a moment to debrief and process the student-faculty meeting with our faculty partner and Carolyn helped to reassure me that I was doing everything possible in the moment. A few faculty participants who were present during the meeting also approached me afterwards to acknowledge that, as RAs, my partner and I had fulfilled our duties. We were able to sit in silence, in uncomfortable moments, and find strategies to move forward in an ethical manner.

## Reflections on Student-Faculty Partnerships and Leadership Development

Through discussing our research experiences with participants who attended our roundtable session at the SoTL symposium, the members of our research team came to recognize how engaging in honest dialogue provides valuable opportunities to understand how to effectively support faculty-student partnerships in SoTL research. Harvey et al. (2010) emphasize that aligning reflection for learning includes the "principles of intent, expectations and authenticity" (p. 145). In reference to these principles, Zizka (2020) has noted that "anything less is unreal, unemotional, and, frankly, un-authentic" (p. 104). Initially we were hesitant to openly share our team's research experiences for fear of triggering difficult memories, but we have since learned how our engagement in ongoing reflection and critical dialogue has nurtured our relationships and built trust between us which were key to supporting our research work, teaching, and learning. Open and honest communication, trust, and collaboration support faculty-student RA partnerships and align closely with the principles of "respect, reciprocity and shared responsibility" (Cooke-Sather et al., 2014). These principles and supportive teamwork restored and strengthened our partnerships and moved us forward in a

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

good way.

The ethics modifications were the impetus for change and transformed my own initial doubts regarding the students' capabilities to lead and manage the unfolding circumstances. By exercising critical thinking, problem solving, and communication, the student RAs navigated changes independently and used their leadership skills to address issues. With reference to experiential learning, Kolb (1984) explained how learners increase knowledge as they move through the steps of a learning cycle, which include reflective observation, abstract conceptualization, active experimentation, concrete experience, and the co-construction of meaning of lived experiences through dialogue. Simran's ability to engage in critical reflexivity by writing about her research and leadership roles in this paper highlights the significance of deep self-reflection and the co-construction of knowledge through dialogue. Simmons and Taylor (2019) have emphasized that "faculty, educational developers, administrators and students can all function as leaders in promoting, sustaining and providing leadership in SoTL" (p. 1). Leadership often involves being comfortable with what is uncomfortable and having confidence and flexibility to make decisions and act when unpredictable changes happen. The RAs' leadership skills and partnerships were tested and strengthened as they faced challenges, applied their knowledge, and found workable solutions. Adding rights to the SoTL principles of "respect, reciprocity, and shared responsibility" (Cooke-Sather et al., 2014) points to the importance of inclusivity in faculty-student research partnerships and includes students' right to have a voice in decision-making, to exercise agency, and to adopt leadership roles. The leadership competencies and knowledge the student RAs gained and the confidence and determination they demonstrated throughout our study was the impetus that aided them in reaching their research objectives.

In the months following the completion of our SoTL study, the research team disseminated the findings through academic conferences and co-authored journal articles. Although the research results raise awareness about the educational experiences of immigrant students in post-secondary settings and the challenges they face, the members of our research team agreed that a significant outcome was learning about ourselves as co-researchers and faculty-student partners. The students came to recognize their leadership competencies through critical thinking and problem solving while facilitating the focus group interviews. My understanding and appreciation of the importance of SoTL principles, practices, and partnerships with student RAs increased significantly. The interruption of the research plans motivated me to think with the students, to plan our next steps together, and to intentionally work collaboratively as a team. Field et al. (2021) ask "if students and supervisors/instructors are unchanged by the partnership and the inquiry therein, what have we learned and who have we become?" (p. 93). The intersecting threads of "respect, reciprocity, shared responsibility" (Cooke-Sather et al., 2014) and rights weave together, creating the metaphorical cord that I now walk upon. Exercising caution and with new appreciation of the pitfalls that can occur during research, I now recognize the potential in partnering with undergraduate student RAs, and I have a greater motivation to advocate for

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

students' right to exercise agency and participate as equal partners in SoTL research.

## FUNDING

We are grateful to the Mokakiiks Centre for the Scholarship of Teaching and Learning at Mount Royal University for providing a SoTL Essentials grant to support this research.

## AUTHOR BIOGRAPHIES

Dr. Carolyn Bjartveit, cbjartveit@mtroyal.ca, is an Associate Professor and coordinator of the Bachelor of Child Studies, Early Learning and Child Care Program at Mount Royal University in Alberta, Canada. She has taught early childhood education from pre-K through to post-secondary levels. Her research areas include curriculum and cultural studies, history and philosophy of early childhood education, and teacher education. Her current research explores how immigrant and international students' identities intersect with curricula in Canadian post-secondary institutions.

Simran Kandola, skand366@mtroyal.ca, is a recent graduate of the Bachelor of Child Studies degree program, Child and Youth Care Counselling, at Mount Royal University. Her interest in research increased after collaborating with her peers on a research project related to human rights and social justice in multicultural post-secondary classrooms. Simran has work experience in both early learning and child and youth care community settings.

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

## REFERENCES

Akpınar, E., Yıldız, E., Tatar, N., & Ergin, Ö. (2009). Students' attitudes toward science and technology: An investigation of gender, grade level, and academic achievement. Procedia—Social and Behavioral Sciences, 1(1), 2804–2808. https://doi.org/10.1016/j.sbspro.2009.01.498

Allchin, D. (2011). Evaluating knowledge of the nature of (whole) science. Science Education, 95(3), 518–542. https://doi.org/10.1002/sce.20432

Allum, N., Besley, J., Gomez, L., & Brunton-Smith, I. (2018). Disparities in science literacy. Science, 360(6391), 861–862. https://doi.org/10.1126/science.aar8480

Allum, N., Sturgis, P., Tabourazi, D., & Brunton-Smith, I. (2008). Science knowledge and attitudes across cultures: A meta-analysis. Public Understanding of Science, 17(1), 35–54. https://doi.org/10.1177/0963662506070159

Bahtiar, B., Ibrahim, I., & Maimun, M. (2022). Analysis of students' scientific literacy skills in terms of gender using discovery model science teaching materials assisted by PhET simulation. Jurnal Pendidikan IPA Indonesia, 11(3), 371–386. https://doi.org/10.15294/jpii.v11i3.37279

Bliuc, A.-M., Ellis, R. A., Goodyear, P., & Hendres, D. M. (2011). The role of social identification as university student in learning: Relationships between students' social identity, approaches to learning, and academic achievement. Educational Psychology, 31(5), 559–574. https://doi.org/10.1080/01443410.2011.585948

Brownlow, S., Jacobi, T., & Rogers, M. (2000). Science anxiety as a function of gender and experience. Sex Roles, 42(1–2), 119–131. https://doi.org/10.1023/a:1007040529319

Buxner, S. R., Impey, C. D., Romine, J., & Nieberding, M. (2018). Linking introductory astronomy students' basic science knowledge, beliefs, attitudes, sources of information, and information literacy. Physical Review Physics Education Research, 14(1), 1–17. https://doi.org/10.1103/physrevphyseducres.14.010142

Cartwright, N. M., Liddle, D. M., Arceneaux, B., Newton, G., & Monk, J. M. (2020). Assessing scientific literacy skill perceptions and practical capabilities in fourth year undergraduate biological science students. International Journal of Higher Education, 9(6), 64–76. https://doi.org/10.5430/ijhe.v9n6p64

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

Chung, E., & Milkoreit, M. (2021). Who are your people?–The effect of political ideology and social identity on climate-related beliefs and risk perceptions. Politics, Groups, and Identities, 11(3), 467–487. https://doi.org/10.1080/21565503.2021.1992287

Drummond, C., & Fischhoff, B. (2017). Individuals with greater science literacy and education have more polarized beliefs on controversial science topics. Proceedings of the National Academy of Sciences, 114(36), 9587–9592. https://doi.org/10.1073/pnas.1704882114

Duschl, R. A., & Grandy, R. (2013). Two views about explicitly teaching nature of science. Science & Education, 22(9), 2109–2139. https://doi.org/10.1007/s11191-012-9539-4

Eveland, T. J. (2019). Supporting first-generation college students: Analyzing academic and social support's effects on academic performance. Journal of Further and Higher Education, 44(8), 1039–1051. https://doi.org/10.1080/0309877x.2019.1646891

Greenfield, T. A. (1996). Gender, ethnicity, science achievement, and attitudes. Journal of Research in Science Teaching, 33(8), 901–933. https://doi.org/10.1002/(SICI)1098-2736(199610)33:8<901::AID-TEA5>3.0.CO;2-%23

Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. Review of Educational Research, 67(1), 88–140. https://doi.org/10.3102/00346543067001088

Holbrook, J., & Rannikmae, M. (2007). The nature of science education for enhancing scientific literacy. International Journal of Science Education, 29(11), 1347–1362. https://doi.org/10.1080/09500690601007549

Impey, C. (2013). Science literacy of undergraduates in the United States. Organizations, People and Strategies in Astronomy, 3, 353–364.

Lederman, N. G. (1992). Students' and teachers' conceptions of the nature of science: A review of the research. Journal of Research in Science Teaching, 29(4), 331–359. https://doi.org/10.1002/tea.3660290404

Lederman, N. G., & Lederman, J. S. (2019). Teaching and learning nature of scientific knowledge: Is it Déjà vu all over again? Disciplinary and Interdisciplinary Science Education Research, 1(1), 1–9. https://doi.org/10.1186/s43031-019-0002-0

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

Lederman, N. G., Lederman, J. S., & Antink, A. (2013). Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy. International Journal of Education in Mathematics, Science and Technology, 1(3), 138–147. https:/files.eric.ed.gov/fulltext/ED543992.pdf

Makarovs, K., & Allum, N. (2023). Social identity and racial disparities in science literacy. Public Understanding of Science, 32(3), 373–388. https://doi.org/10.1177/09636625221141378

Mallow, J. V. (1994). Gender-related science anxiety: A first binational study. Journal of Science Education and Technology, 3(4), 227–238. https://doi.org/10.1007/bf01575898

McComas, W. F., Almazroa, H., & Clough, M. P. (1998). The nature of science in science education: An introduction. Science & Education, 7(6), 511–532. https://doi.org/10.1023/a:1008642510402

Medina, S. R., Ortlieb, E., & Metoyer, S. (2014). Life science literacy of an undergraduate population. The American Biology Teacher, 76(1), 34–41. https://doi.org/10.1525/abt.2014.76.1.8

Megreya, A. M., Szűcs, D., & Moustafa, A. A. (2021). The Abbreviated Science Anxiety Scale: Psychometric properties, gender differences and associations with test anxiety, general anxiety and science achievement. PLoS ONE, 16(2), 1–20. https://doi.org/10.1371/journal.pone.0245200

Meisha, D. E., & Al-dabbagh, R. A. (2021). Self-confidence as a predictor of senior dental student academic success. Journal of Dental Education, 85(9), 1497–1503. https://doi.org/10.1002/jdd.12617

Michel, H., & Neumann, I. (2016). Nature of science and science content learning. Science & Education, 25(9–10), 951–975. https://doi.org/10.1007/s11191-016-9860-4

Miller, P. H., Blessing, J. S., & Schwartz, S. (2006). Gender differences in high-school students' views about science. International Journal of Science Education, 28(4), 363–381. https://doi.org/10.1080/09500690500277664

Morganson, V. J., Jones, M. P., & Major, D. A. (2010). Understanding women's underrepresentation in science, technology, engineering, and mathematics: The role of social coping. The Career Development Quarterly, 59(2), 169–179. https://doi.org/10.1002/j.2161-0045.2010.tb00060.x

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

Nix, S., & Perez-Felkner, L. (2019). Difficulty orientations, gender, and race/ethnicity: An intersectional analysis of pathways to STEM degrees. Social Sciences, 8(2), 1–29. https://doi.org/10.3390/socsci8020043

Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. Science Education, 87(2), 224–240. https://doi.org/10.1002/sce.10066

Rudolph, J. L. (2000). Reconsidering the "nature of science" as a curriculum component. Journal of Curriculum Studies, 32(3), 403–419. https://doi.org/10.1080/002202700182628

Snow, C. E., & Dibner, K. A. (2016). Science literacy: Concepts, contexts, and consequences. Proceedings of the National Academy of Sciences. https://doi.org/10.17226/23595

Stroupe, D., Suárez, E., & Scipio, D. (2025). Epistemic injustice and the "Nature of Science." Journal of Research in Science Teaching, 62(4), 901–941. https://doi.org/10.1002/tea.21988

Strzalkowski, N., & Sobhanzadeh, M. (2023). Views and value of an undergraduate general education on advancing student attitudes and engagement with science. Imagining SoTL, 3(2), 89–119. https://doi.org/10.29173/isotl687

Terry, D. J., Hogg, M. A., & White, K. M. (1999). The theory of planned behaviour: Self-identity, social identity and group norms. British Journal of Social Psychology, 38(3), 225–244. https://doi.org/10.1348/014466699164149

Udo, M. K., Ramsey, G. P., & Mallow, J. V. (2004). Science anxiety and gender in students taking general education science courses. Journal of Science Education and Technology, 13(4), 435–446. https://doi.org/10.1007/s10956-004-1465-z

Ustun, U. (2023). Motivation's role in students' science literacy and career expectations. Scandinavian Journal of Educational Research, 68(4), 824–841. https://doi.org/10.1080/00313831.2023.2229356

Verdin, D., & Godwin, A. (2015). First in the family: A comparison of first-generation and non-first-generation engineering college students. 2015 IEEE Frontiers in Education Conference, 1–8. https://doi.org/10.1109/fie.2015.7344359

*Imagining SoTL, Volume 5(2)* (2025)
*ISSN 2563-8289*

Walls, L. (2016). Awakening a dialogue: A critical race theory analysis of U.S. nature of science research from 1967 to 2013. Journal of Research in Science Teaching, 53(10), 1546–1570. https://doi.org/10.1002/tea.21266

Woitkowski, D., Rochell, L., & Bauer, A. B. (2021). German university students' views of nature of science in the introductory phase. Physical Review Physics Education Research, 17(1), 1–11. https://doi.org/10.1103/physrevphyseducres.17.010118

Woitkowski, D., & Wurmbach, N. L. (2019). Assessing German professors' views of nature of science. Physical Review Physics Education Research, 15(1), 1–13. https://doi.org/10.1103/physrevphyseducres.15.010108

Yacoubian, H. A. (2017). Scientific literacy for democratic decision-making. International Journal of Science Education, 40(3), 308–327. https://doi.org/10.1080/09500693.2017.1420266