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Using interdisciplinary dialogue to understand the influence of identities on undergraduate research experiences

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INTERDISCIPLINARY DIALOGUE AND UNDERGRADUATE IDENTITIES

Abstract

To face twenty-first century challenges, an effective undergraduate education must prepare its students with interdisciplinary competencies: reflexivity, perspective seeking, and integrative thinking that reaches across disciplinary silos. As such, higher education has begun to shift towards societally engaged models that engender interdisciplinary collaboration. However, much of the work on interdisciplinarity focuses solely on intellectual concerns, missing out on key opportunities to center personal spheres of knowledge. To address this gap, we implemented interdisciplinary dialogue as a practice-based approach to facilitate conversation on how identity, privilege, and access shape undergraduate students' experiences in mentored undergraduate research settings. Between 2021 and 2022, we facilitated four peer dialogue workshops with students participating in discipline-based summer undergraduate research programs (n=54) where peers among different disciplines discussed how personal and disciplinary identities influence access to opportunities, choices in research, research process, and relationships. Thematic analysis of conversations within these dialogues revealed how students conceptualize the role of their own and others' identities when describing their reasons for doing research, how they gained access to and navigated research spaces, and how they conducted the research itself. Undergraduate students described research as being highly personal as they consistently discovered, iterated, and embodied their unique identities throughout the research process, and adding a point of peer dialogue allowed students to explore these perspectives. By showcasing the ways that students articulate and negotiate their identities as researchers in dialogue with one another, we demonstrate the value in incorporating these discussions within interdisciplinary higher education.

Introduction

From the global to the local level, society faces challenges which require new ideas and collaborative thinking. Issues like climate change and global health crises require collaboration between professionals in multiple fields, necessitating interdisciplinary collaboration. As trainees who are poised to inherit these realities, undergraduate students are faced with a significant need to develop collaborative and creative problem-solving skills. In turn, it is incumbent upon higher education to provide opportunities for undergraduates to develop these competencies. In particular, there is a need to enhance students' interdisciplinary consciousness: a set of competencies and attitudes that foster reflexivity, perspective seeking and integrative thinking (Imbruce et al., 2024; Kjellberg et al., 2018; Repko & Szostak, 2020). These competencies not only provide students with the skills necessary for research and education, but they also enable students to place themselves, and their scholarly pursuits, within larger societal contexts. Interdisciplinary consciousness can cultivate acceptance of differences in self and others. However, interdisciplinary education tends to focus on topics squarely about academic and intellectual concerns, such as epistemology, disciplinary assumptions, and genre of communication, rather than taking a whole student approach that encompasses personal spheres of knowledge through lived experience by class, race, ethnicity and gender and how they shape disciplinary views and experiences. Students bring a myriad of personal experiences that shape the choices they make about what to study, with whom, and how, in turn affecting their own as well as the learning experiences of others (Fam, 2017; Freire, 2000; Wenger-Trayner, 2008; Wenger-Trayner & Wenger-Trayner, 2015). We demonstrate that opening interdisciplinary educational methods to include a focus on personal identity attributes alongside disciplinary ones is constructive towards the goals of preparing students for the choices they will make, interactions they will have, and challenges they will face throughout their higher education as well as in their professional lives.

Our conceptual approach to this problem is to apply peer dialogue to raise interdisciplinary consciousness and facilitate student discussion on the ways that their own and others' identities, positionalities, and values influence their research experiences. We ask, how do undergraduate student

researchers conceptualize the influence of personal identity within their discipline-based research experiences? We previously reported on the method used to facilitate peer dialogue and its utility in enhancing undergraduate students' consciousness of the role of discipline in their research experiences (Imbruce et al., 2024). The dialogue is conducted in a workshop setting during a summer undergraduate research program and is guided by a series of structured prompts presented to students at the start of the workshop and lightly facilitated throughout the dialogue to elicit students' reflections and peer-to-peer discussion. Each student is working on a research project of their own design, based in a discipline from the humanities, arts, natural or social sciences. The dialogue provides students of a mixed set of majors and discipline-based research projects with time and space not encountered in other parts of their education to interrogate their own and others' perspectives. In the present study we build on this work. We recorded, transcribed, and thematically analyzed the peer dialogue between groups of undergraduate researchers, aiming to center students' perspectives on the role of identity and discipline in their research experiences. This research will enable scholars, educators, and program administrators to understand how students conceptualize, articulate, and navigate personal and disciplinary identity factors in UR in order to better support student success.

Identities in undergraduate education

As young professionals and trainees, undergraduate students continuously construct and reconstruct their own personal and disciplinary identities, deepening their understanding of themselves throughout their learning experiences. Research on undergraduate science identity tells us that conceptions of identity are both socioculturally and experientially constructed (Le et al., 2019). Identity is a confluence of what one thinks and what one does (Le et al., 2019) and includes two sets of influences: internal (i.e., how individuals see themselves) and external (i.e., how individuals are recognized and assessed by others). Identity development is a process in which individuals are constantly drawing upon resources and opportunities around them to build their cultural capital - tastes, preferences, ideas, and symbols - and leverage that capital within social relations (Remich et al., 2016). This is an iterative process which is influenced and constrained by cultural context as well as the social histories of

individuals, their families, and other identity groups to which they belong (Marco-Bujosa et al., 2024). Students navigate their disciplinary and budding professional identities alongside all other facets of their identity, for example, race, ethnicity, gender, sexuality, college identity, identity as an athlete, part of Greek organization, or other extracurriculars. Students with marginalized identities must navigate stereotypes, microaggressions, and multiple identities within educational spaces, which can create conflict and negatively affect students' scientific identity development and persistence in STEM majors and careers (Marco-Bujosa et al., 2024; McGee & Martin, 2011; Remich et al., 2016).

As students continuously undergo the process of identity development throughout their undergraduate experiences, evidence suggests that adding intentional points of reflection can help to shape and make sense of it. Previous work has emphasized the importance of opening opportunities for undergraduate students to reflect on their curricular and co-curricular activities because it allows them to connect their experiences to their views of themselves within their discipline (Leyva et al., 2021; Linn et al., 2015; McGee & Martin, 2011). However, students often lack explicit opportunities to do so (Linn et al., 2015). Our peer dialogue among undergraduate researchers from different disciplines thus presents the opportunity for students to reflect on and share how they see themselves within their educational contexts.

Dialogue as an avenue for critical reflection

Engaging in dialogue is a powerful avenue for individuals to share and jointly reflect on their experiences. Dialogue enhances self-awareness and mutual understanding by encouraging reflection on one’s beliefs in relation to others (Rinkus & O’Rourke, 2020). Fostering dialogue, especially among heterogeneous student groups (e.g., those with different identities and disciplinary backgrounds), can enhance shared understanding of how different individuals conceive, practice, and experience their educational opportunities (O’Rourke et al., 2014). Dialogue among peers from different disciplines has been demonstrated to raise interdisciplinary consciousness by creating a space for students to discuss their experiences, learn from others, and enrich their ideas of how they see themselves (Imbruce et al., 2024). Furthermore, engaging in dialogue about similarity and difference in students’ learning experiences and perceptions of who they are, personally, in relation to what they study and who they are becoming, can

help to "start the conversation" (Smith-Keiling et al., 2020). Doing so, individuals are encouraged to reflect on the ways that their own identities, positionalities, and cultural context (disciplinary, institutional and social) influence their perspectives.

Undergraduate research as a site for interdisciplinary education

Mentored undergraduate research (UR) can be a powerful modality for students to experience learning and self-growth alongside their peers while acquiring both specialized and generalized skills. UR can lead to high levels of student success (Chamely-Wiik et al., 2023; Knezek et al., 2022), and can be influential on the types of careers that students pursue (Hazari et al., 2010; Huffmyer et al., 2022). Furthermore, UR is influential in the development of students' identity within their discipline (Hazari et al., 2020; Palmer et al., 2018). Students' conceptions of their own identities affect reflections on the ways that they practice research, interact with others, and exist within their social context (Faber et al., 2020; Marco-Bujosa et al., 2024). As such, there has been increased attention within higher education to foster such experiences across institutional types and disciplines (*Boyer 2030 Commission Report*, 2022; Chamely-Wiik et al., 2023; Kuh, 2008; Lopatto, 2007; Mekolichick, 2021).

UR presents an opportunity for interdisciplinary education by serving as a vehicle for students to take deep dives in different areas, exposing them to a range of disciplines and approaches. Students individually move between different types of discipline-based research throughout their undergraduate careers, and select students may also participate in research programs of mixed disciplinary cohorts. Therefore, it is logical to look at UG research programs as a locus to enhance interdisciplinary consciousness, particularly through dialogue as a unique intervention.

The current study

Our study presents the critical reflections of undergraduate student researchers on the influence of identity (broadly defined) on their research practice. We adapted a well-established, practice-based research method to fit an undergraduate research setting, adding a set of prompts about identities to open up new lines of discussion (see "Toolbox dialogue method" section below). By engaging in peer dialogue, undergraduate student researchers were invited to practice their interdisciplinary competencies of

reflexivity, perspective seeking, and integration of ideas, by openly discussing their own and others' identities, positionalities, and values related to research.

In a previous paper, we describe this dialogic intervention and its utility in enhancing interdisciplinary consciousness in undergraduate researchers (Imbruce et al., 2024). In this paper, our research aim is to center student perspectives shared within these dialogues to (a) understand their perceptions of the role that identities play in research, and (b) examine the ways that students articulate and negotiate their identities in peer dialogue about UR. As such, our analysis is structured around the following research question: How do undergraduate student researchers conceptualize the influence of personal identity within their discipline-based research experiences? Our exploration of this question contributes to the broadening of our understanding of students' experiences with their own personal identity factors in disciplinary-based research settings. Ultimately, this understanding can help us to broaden interdisciplinary educational methods to include more explicit focus on multiple identity factors.

Methods

Study context and participants

Our study population included students participating in one of five summer undergraduate research programs at a large, public university in upstate New York, USA. We decided to target multiple research programs to better ensure a broad selection of students from diverse experiential and disciplinary perspectives. Students led their own discipline-based projects that they designed, received endorsement for by a faculty mentor, and proposed in a competitive application process for an eight-week paid, mentored, summer research program. A detailed description of each program and their admission requirements can be found in Appendix S1. Though each program had slightly different structures, they all shared the fundamental goal of undergraduate students conducting mentored research throughout the summer. The disciplines supported by these programs were diverse, including students in engineering, biology, and chemistry to art, history, and literature. Research activities throughout the summer were conducted independently with a faculty mentor, sometimes in research teams and sometimes as individuals. All programs included occasional meetings throughout the semester for students to introduce

and discuss their projects with other students within their programs, while some programs had more opportunities for social cohort formation through recreation and professional development seminars. Students in these programs included those with previous research experience as well as those for whom this was the first research experience. By and large, students were doing discipline-based research, not interdisciplinary projects. We see summer research programs like these to be an opportunity to add interdisciplinary educational interventions, to broaden students' abilities to reflect on their own disciplinary assumptions and norms, and contrast those norms and assumptions with others. We conducted our study with two cohorts of students in these programs across two years in July 2021 (n=33) and July 2022 (n=26). All students in the summer research programs in 2021 and 2022 were contacted with an invitation to participate in the dialogue workshops several weeks prior to the workshop in August (near the end of their 10-week program) via the normal mechanisms of communication within their programs (e.g., program emails and reminders at program meetings). Some programs required their students to attend, while for others, attendance was optional. Participant demographic information and disciplinary identity is available in Table 1.

Toolbox dialogue method

To facilitate student dialogue, we utilized the Toolbox dialogue method (O'Rourke et al., 2014). Typically delivered in a workshop setting, a Toolbox dialogue is guided by a series of prompts that provide topics for discussion using the "Toolbox instrument" (Eigenbrode et al., 2007). This survey-style instrument is organized into thematic modules that are each framed by a core question and followed by a set of prompts designed to elicit the various perspectives within a group. Participants rate their agreement or disagreement with the prompts using a rating scale from disagree to agree. However, unlike a typical survey, the main function of the instrument is to promote reflection and stimulate interactive dialogue; therefore, the items are not designed to evaluate specific psychometric constructs (Rinkus et al., 2021). The prompts instead encourage participants to take a position independently while motivating curiosity and initiating discussion as to why a rating was chosen. Toolbox dialogue enhances self-awareness and mutual understanding, without requiring agreement, by engaging in a dialogue structured around

disciplinary epistemologies (Rinkus & O'Rourke, 2020). Originating from a National Science Foundation (NSF) - sponsored Integrative Graduate Education and Research Traineeship project, the method has been applied in multiple contexts (Hubbs et al., 2020) including with cross-disciplinary research teams, undergraduate students in an interdisciplinary curriculum (Kjellberg et al., 2018), and as a core activity in Responsible Conduct of Research trainings for graduate students (McLeskey et al., 2020).

The Toolbox instrument used for this workshop was adapted from Kjellberg et al. (2018) and included four modules to prompt discussion around the following dimensions of research: Objective, Audience, Inputs and Outcomes, and Process. To meet our study aims, we adapted the prompts to use appropriate language and objects of thought for undergraduate researchers. In addition to the four modules adapted from Kjellberg et al., we also included a new module on the research dimension of "Identities" related to this core question: How do researchers' identities shape research (includes creative activity) in general? Each module included 5-6 prompts intended to elicit reflection on individual perspectives of topics within each dimension of research (see Appendix S2 for all prompts).

Data collection

The workshops were conducted primarily with a capacity building goal to create an explicit space for students to interrogate their own and others' conceptions of research and identity across disciplines by practicing the interdisciplinary skills of reflexivity, perspective taking, and integration. The workshop itself is designed as a practice-based research method in which data are generated throughout the workshop in the form of responses to the dialogue prompts, the transcription of the dialogue itself, and responses to post-dialogue questions. The research portion of our workshop endeavors to understand the students' perspectives that developed throughout the dialogue surrounding how the roles of identity and discipline are operating within the undergraduate student research experience. The student perspective is what we consider the measurable qualitative research outcomes. Following this rationale, we did not intend to look at differences in students' experiences with their identities in research across academic levels or programs, but rather to understand the ways in which the participating students articulate their experiences and perspectives overall.

Workshops employing the Toolbox dialogue method were conducted with students participating in summer undergraduate research programs during July 2021 and July 2022. In each year, two workshops were conducted with students grouped together according to their corresponding summer research program (Appendix S1), resulting in four total workshops across both years. The workshops began with a preamble which oriented students to the Toolbox dialogue method, an explanation of the informed consent, and guidelines for the dialogue before being divided into one to three small groups of five to 10 students, each with one or two facilitators (one primary facilitator and one primary notetaker). Author 1, Author 4, Author 5 and three other trained facilitators participated in facilitation roles across one or both years. Students were assigned a participant number (P#) in order to de-identify the data collected.

Prior to the start of the dialogue, students completed the Toolbox instrument through an online application where they rated each prompt using a scale from 1 (disagree) to 5 (agree), including two additional options of 'don't know' and 'not applicable.' Demographic information was also collected through the instrument (Table 1), where students selected their race/ethnicity(ies) and disciplinary orientation from a drop-down menu selection and were provided a blank field for their gender identity.

After students completed the Toolbox instrument, the facilitator opened the dialogue by inviting students to suggest a prompt from the instrument for discussion, leading to conversational interaction among participants. These dialogues lasted between 70 and 90 minutes. Following the dialogues, all participating students completed the same Toolbox instrument a second time. They also responded to four open-ended questions designed to assess learning outcomes of the workshop (Appendix S2). The dialogues were recorded and transcribed with participant consent (Michigan State University IRB Study #00005341, Approved 11/5/2020). Of the 59 students who participated in dialogues, five students did not consent for their data to be used for research purposes and were excluded from analysis (final sample n=54, see Table 1). Declining research participation did not influence the ability of students to engage in the dialogue.

While both 2021 and 2022 dialogues followed the same Toolbox instrument, they differed slightly in their delivery and methodology. Due to the COVID-19 pandemic, the 2021 dialogues were held virtually using Zoom, whereas the 2022 dialogues were held in-person on the university campus where the student research was conducted. In addition, in the 2021 dialogues, conversations moved around prompts based solely on the students' interests, with facilitators only intervening as needed to encourage participation or ask for clarification. In the 2022 dialogues, conversations were more actively facilitated to ensure equal time (20 minutes) was spent discussing each of the five modules, though students continued to direct the specific prompts discussed within those modules according to their interests. We arrived at this decision based on our experience in the initial year where not all student dialogue groups were able to discuss all five modules in the allotted time, hindering the workshop's goal of facilitating a discussion on each of the five dimensions of research.

Analysis

To analyze the student dialogues, we employed inductive thematic analysis. Thematic analysis is a qualitative coding procedure that aims to identify and analyze patterns of meaning within the data. Thematic analysis involves six-steps: 1) familiarization with the data by reading the transcripts; 2) developing initial codes that identify salient features in the data; 3) applying the codes, and collating or refining the codes as needed; 4) identifying themes or broader patterns of meaning represented among the codes; 5) reviewing the potential themes to see which need to be refined, combined, split or discarded and which are most relevant to the primary research questions; 6) naming and defining the themes and generating a report based on the final thematic narrative (Braun & Clarke, 2006).

Thematic codes were inductively derived from the data and describe the thematic content of what students were talking about (Table 2). To develop the thematic codes, the full author group independently read and reread each dialogue transcript, noting recurring and salient themes that served as the initial codes. Following this approach, the group met frequently to further refine, combine, divide or omit categories (Braun & Clarke, 2006; Patton, 2002).). When penultimate codes were agreed upon, authors pilot tested code applications on sections of student dialogue transcripts, and code definitions were further

refined using salient dialogue topics as a guide. Following this iterative process, all five authors arrived at consensus on the codes and code definitions. A finalized codebook of thematic codes is reported in Appendix S3 and summarized in Table 2.

After finalizing the codebook, Author 1 and Author 2 each coded all transcripts using Dedoose software (SocioCultural Research Consultants, 2021). Each coder independently applied codes to each speaking turn. Coders then met frequently to discuss each instance of code application disagreements, and consensus was reached on each code application by discussion, clarification, and occasionally updating the definitions and examples given in the codebook (Appendix S3). Excerpts within each code were then examined to extract the thematic narrative.

To triangulate our results (Creswell & Poth, 2018), we reviewed each of the student post-dialogue learning outcomes as a mechanism to contrast our analysis of student dialogues. While not part of the thematic analysis, we introduce representative student quotes from the learning outcomes for illustration and as additional evidence (Bernard, 2006, p. 503-505). The rating responses to the prompts in the Toolbox instrument are not presented in this analysis as they were not designed to measure discrete constructs and instead served the primary purpose of prompting reflection and discussion within the dialogues.

The findings are organized to reflect the thematic narratives related to identities. Demographic identifiers (discipline, race/ethnicity, and gender) for each quoted participant are included in order to provide the reader with context for each speaker beyond their quote; however, these identifiers should be used only for the purpose of providing context, and the authors caution against relying solely on individual aspects of identity when interpreting meaning. Our presentation of the findings reflects the relevance and salience of the themes based on their occurrence across dialogues and the significance as expressed by the participants themselves and as related to our research question about the influence of identities in UR.

Dialogue themes

The main themes reflected in student dialogues were as follows: (1) Students do research for personal reasons (related code: Research Relevance), (2) Access to research depends on social connections (related codes: Identities-Access; Mentorship), (3) Navigating internal and external perceptions in research experiences (related codes: Identities-Positionality; Identities-Trust in Self or Others; Communicating Research), and (4) Considering values and biases while conducting research (related codes: Research Process; Ethics; DEI Lens in Research; Epistemology). In the following sections, we highlight salient conversations and quotes related to each theme as discussed by students in the dialogues.

Students do research for personal reasons

"I think all researchers have to have [a] certain investment emotionally in their research to do it effectively."[1]

One recurrent theme was that students viewed their own reasons for pursuing research experiences as being highly personal to their own identities, positionalities, and values. In particular, when presenting their rationale for conducting research, students described a mix of both internal and external relevance.

Internal relevance was primarily related to career and skills development, with most students agreeing that UR is a set of experiences that can boost their knowledge as professionals and serve their career aspirations. Conducting research was also viewed as being internally rewarding towards non-instrumental goals such as self-improvement or a general interest in learning. Separately, external relevance for pursuing research included desire to benefit scholarship or society. For example, students described a desire to benefit the pursuit of knowledge within their discipline, academia, or the broader body of scholarship. Additionally, students wished to contribute to societal benefit, either related to specific people or contexts (e.g., healthcare or policy recommendations) or things like "the greater good." Students also pointed out their disciplinary perspectives influenced their desired research outputs (e.g.,

[1] Student in an engineering discipline who identified as mixed race and male

policy recommendations for political science discipline vs. theoretical/intellectual contributions without explicit recommendations from biochemistry research).

Students described that they held multiple motivations for conducting research which overlapped or shifted over time. For example, while contributing to solving a societal issue may have been an original motivation for pursuing research, students recounted gradually gaining appreciation for its value in their own self-improvement as their research experiences progressed. Interestingly, some students held a negative view of the idea of conducting research for the sake of internal or personal gain (e.g., career advancement), indicating values that favored external relevance (e.g., benefiting society). One exchange between two students, one from the life sciences who identified as Asian and female (Student A) and one from the physical and mathematical sciences who identified as White and male (Student B), exemplified the dissonance that some students felt in navigating these values:

> Student A: It just seems sort of very – I don't want to say selfish, but self-centered goal for someone's research to be to advance their own career.
> [...]
> Student B: I think I could push forward a bit of a different perspective. [...] I would argue that probably the primary goal of undergraduate research is to advance our careers. I know that sounds scary. I could see how a lot of people would see that as self-centered.

Access to research depends on personal connections

"It's not about the grades you get, it's about the hands you shake"[2]

A second recurrent theme was the accessibility of UR as being dependent on personal factors: who is able to access UR, and why (or why not)? Reflecting on both their own experiences (as those who successfully secured a research position) and their perception of others' experiences (particularly those who do not have a research position), students described the identity attributes of financial position, life history, social groups, and discipline, which they perceive to be supports or barriers for those seeking UR opportunities.

Students described that access to social connections significantly altered their own trajectories as researchers. It was often other people within their social networks (e.g., faculty mentors or friends) who

[2] Student in a life sciences discipline who identified as mixed race and female

directed them towards research programs. Faculty mentors in particular were cited as being a key social connection who facilitated student access to research. Students who learned about research opportunities this way credited social connections as being especially important because they viewed opportunities as being otherwise difficult to find due to lack of advertising or easily accessible information. This was especially implied to be the case for students from historically underrepresented backgrounds who may otherwise lack knowledge of the "hidden curriculum" (Jackson, 1993) of academia. As voiced by one student from psychology discipline who identified as Hispanic and male:

> In terms of finding opportunities, I feel like it's not advertised at all [...] so a lot of underrepresented students can't really know about these programs. [...] The way I got into my research lab was essentially going into my professor's office hours and speaking to him about his research until one day, he suggested I reach out to his graduate student [...] This is one way of going about doing it, but if I didn't necessarily do that, or wasn't enrolled in CSTEP, then I would not be here and there would be no research opportunities. So, I feel like trying to help each other find these opportunities is very important, something that should be more focused on.

Grades, academic standing, and availability of quality preparation in high school were seen as important factors for gaining access to research that varied depending on students' identities. For example, students described that requiring a minimum GPA for research experiences represented a barrier for applicants, especially for those from historically underrepresented backgrounds, because grades are influenced by multiple factors largely outside of a student's control. Some students had competing demands outside of school (e.g., work responsibilities) or minimal support to prepare for college, which were cited as affecting GPAs while not accurately reflecting ability or inability to conduct research. Students also perceived an association between coming from more advantaged backgrounds and having higher quality preparation in high school, creating advantage in gaining access to research in college. One student from the life sciences who identified as female and mixed race described:

> I think even coming in as a freshman, if you went to a high school that introduced you to research and taught you to join a research lab from an early age, you're already at that advantage. I think that even professors, when they're choosing people to work in their labs, they do tend to choose a freshman over a senior because this freshman will be able to stay in the lab for four years and long-term they can teach them a lot more, so they will choose to teach freshman. So, if you're coming from a high school that had more resources to prepare you for college, you're already advantaged.

Identity attributes of financial position and socioeconomic status represented additional factors which affected access to research opportunities. Those who faced more financial constraints were forced to be more cognizant of the research opportunities available to them, describing the need to balance the perceived benefits of research with the need to work in external jobs to provide necessities like food and rent. Students who had previously participated in unpaid research programs, which they perceived as necessary for their career development, expressed a need to divide their hours between research and work, leaving them tired and overwhelmed. Students with fewer resources also reported financial challenges associated with conference travel, which they viewed as critical opportunities to build their social networks and develop their professional skills. However, on the positive side, being part of a UR program which provided a stipend allowed students to reduce their hours in external jobs, simultaneously reducing financial stress and allowing them to engage in critical career development. Many students engaged in these discussions by recognizing and acknowledging their own privilege in relation to others. For example, a law student who identified as White and female described:

> There are some people who work and do this program, or take a class or internship or something and do this program. I've noticed that their experience is a lot different than my experience where I'm doing this mostly full-time [...] I'm able to focus more on my research and really dive into it, where other people don't really have that privilege because they have to work or take a class or something.

Students in all disciplines expressed a perception that research opportunities were more accessible for individuals in science, engineering, technology, and mathematics (STEM) fields than for those in the social sciences and humanities. Indeed, three of the five summer research programs offered at this university, and thus those included in this study, had a focus or requirement for students to be conducting research in a STEM field (Appendix S1). The students acknowledged that the skew of priorities for the specific institution that they attend could be the reason that they have this perception, as perhaps humanities students would have expanded opportunities at other institutions. One student from the humanities who identified as White and female described:

> I definitely didn't think that the opportunity for humanities students like this [program] existed here, solely because it's such a science-focused school. The only reason I heard about this was, a professor emailed me. [...] I think there are a lot more opportunities for science students at

> schools like Binghamton, and I feel like liberal arts schools probably have more opportunities for humanities students.

Finally, throughout discussions of access, a recurring theme was related to students attributing their own and others' successes to luck or "being lucky" as opposed to internalizing the successes as being a result of their own hard work or actions.

Navigating internal and external perceptions in research experiences

"If you say, "I'm an undergraduate researcher," I think the initial assumption is to treat you with an enhanced level of skepticism or perhaps try and test you a little bit more to see if you really do belong in the research community."[3]

A third recurrent theme within the dialogues was the ways that students contextualize their own identities as they navigate their research experiences. On one hand, students found their unique positionalities as a source of strength. They viewed their "personal touch" as bringing value to their work, and they felt a sense of pride when their unique ideas coupled with hard work yielded positive results. As one engineering student who identified as mixed race and male stated:

> I feel like as we put ourselves into the research, we get more value out of it at the end of the day just because of who we are. For example, when you're a gardener, maybe you talk to your plants because you know that plants like being talked to. Another researcher might not do that. So having that unique aspect of yourself shown in your research, I think that'll bring value to it.

On the other hand, students discussed experiences where they had to navigate the ways that their identities influenced the degree to which others respected or acknowledged their work. Students shared feelings of scholarly anxiety related to their relative lack of experience as undergraduate researchers, expressing a sense that more experienced scholars treated them with "enhanced level[s] of skepticism." Students also shared specific experiences in academic settings where their identities were minimized or discriminated against. For example, a student from a life sciences discipline who identified as Black and female shared that, "as a person of color you have to work even harder to ensure that your first impression is just so different from the stereotypes of what is already in people's minds." Students recounted managing these situations by either changing their behaviors (e.g., code-switching) (Blom & Gumperz, 1972) or leaving the space altogether in search of a more inclusive environment. For example, one student

[3] Student in a social and behavioral sciences discipline who identified as White and male

who identified as female and Hispanic describes switching majors from engineering to chemistry after an experience of gender discrimination in an engineering class:

> Taking that course, it was just me and two other girls and the rest were just all male. [...] When I was taking that class, that was the time for me where I realized my opinion doesn't really matter to whatever I say, compared to them, especially if it came to talking about cars or just anything engineering. That made me decide to switch to the chemistry route.

When communicating their knowledge to others, students expressed shifting feelings of safety and comfort based on who is in the room and how they feel about their own levels of knowledge and expertise related to those individuals. For instance, presenting research in front of their peers was perceived as less threatening while presenting to professors or other experts in a field was perceived as more threatening. However, while some students discussed anxiety in presenting research to professors, others specifically praised their mentors for creating comfortable working environments where they felt freer to make mistakes or speak their mind without fear of repercussions or judgment.

Considering values and biases while conducting research

"Your identity determines what you're interested in researching, [which] in turn shapes the conclusions you may draw from data."[4]

Another recurrent theme was related to how individual researchers' identities influence the conduct and outputs of research itself. Students perceived that individuals choose what to research (e.g., discipline, topic selection) and how to conduct research (e.g., priorities, decision-making, interpretation of research findings) based on their identities, positionalities, disciplines, and values. When examining themselves, students described that their own identities influenced the ways that they conducted research. For example, one engineering student who identified as mixed race and male purposely designed his research to reflect his own values and benefit marginalized populations. However, this student expressed some difficulty in trying to align both his research goals and personal goals:

> It's kind of this cycle for me where I keep tripping over myself because I want to complete something for this program, but I also want to make something that I think is legitimately useful. Those two things, within a certain timeline, are difficult to meet up.

[4] Student in a physical sciences and mathematics discipline who identified as Black and male

Similarly, students discussed their identities as members of a particular discipline(s). Students recognized that the research methods they employ are part of their discipline, and that other disciplines may have different ways of doing research. Scientific disciplines were viewed by all students as being more objective than humanities disciplines, but the extent to which pure objectivity was seen as necessary depended on a student's disciplinary orientation. For example, as described by one student in a social and behavioral sciences discipline who identified as White and male:

> I'm doing research on a cartoonist, which is writing and art at the same time. [My research is] not as much reading numbers and statistics […] but it's more like reading experts and putting my own thoughts in conversation with established voices. I think, in that aspect, there's definitely no one truth.

Others discussed internal conflicts in which their research practice and personal values were at odds. For example, one student who identified as female and mixed race described her motivation for conducting ecological research as a desire to benefit the environment; however, when her research practice required her to remove hemlock twigs and spiders, she experienced some cognitive dissonance as she felt she was acting against her values:

> I feel like I'm – how should I say it? I'm doing more harm than good at this point, although it's going to contribute to further research that would benefit preservation efforts.

Students agreed that researchers have implicit and explicit biases related to their identities and worldviews that can show up throughout the research process. When describing their own experiences as researchers, students mentioned examples where they were able to identify and reflect on their own biases when formulating research questions, designing data collection instruments, analyzing findings, and assessing existing literature. One student conducting research in film who identified as Black and male recounted working with his advisor to minimize the ways that his own preconceptions influenced research and interview questions. The overall sentiment related to bias in research was exemplified by this student:

> I think we all have inherent biases that no matter what we do can show up and affect our research. […] But I think the goal is for most research to try to work against your biases.

When discussing how to navigate the bias of other researchers, several students pointed to experts in their field who are now labeled as racist or sexist; while these labels did not necessarily lead them to

discredit past knowledge, it created an additional lens through which they saw the expert. As stated by one student from the arts and humanities who identified as Asian and male:

> I'm able to separate their work from their research, but inherently there's going to be some part of the researcher in the work. So, you have to look at it through a tipped lens, try to figure out what part is actually good research, and what part is […] just their own biases.

Students discussed how bias can also show up in how participant groups are constructed. The students especially considered these issues in reference to the exclusion of historically underrepresented groups from research projects intended to benefit all of society (e.g., the exclusion of women from a clinical trial for a general-use drug). Having an awareness of this institutional exclusion led some students to feel a sense of responsibility in their role as researchers. For example, a student studying skin health who identified as Black and male noticed that evidence in his field was primarily coming from studies on subjects who were White, and this realization led him to expand his lab's research to include Black skin. Discussion of examples like this led to awareness among some students that research was not as objective as they initially had believed it to be, and that institutional racism, sexism, and ableism are embedded in research practices.

Dialogue intervention and student learning outcomes

Responses to post-dialogue learning outcomes (Appendix S2) by students who took part in the dialogues reveal how students saw the dialogue intervention as an opportunity to discuss identity concepts (e.g. equity, justice, subjectivity) and personal approaches to research (e.g. research as a way to express oneself) they were not familiar with. Students became more aware of their individual perspectives and how their discipline has influenced them. Their reflections revolved around how the dialogue prompts could be discussed from various disciplinary viewpoints they had not considered before. A recurring theme in the students' reflections was how they felt encouraged to look at their research from a broader perspective, including elements from other disciplines. Representative learning outcome responses from three students are included below.

> I am so focused on being unbiased that I lost the plot of what it means to be diverse and have justice, equity and inclusion.[5]

> The inputs from my peers were extremely helpful in the way that I can see the prompt viewed in a different way. I was able to understand the prompt from a social science point of view and as well as just another view as it is hard to see something different.[6]

> I learned that my intellectual perspective focuses on a scientific viewpoint and not always a social one and it might be important to take social issues and beliefs into consideration.[7]

Future work to promote dialogue among students could benefit from adapting the Toolbox dialogue method (Hubbs et al., 2020) to different contexts and varying purposes (O'Rourke et al., 2024). As described, we came to our workshops with the goal to build capacity; as such, the instrument prompts were designed to foster interdisciplinary consciousness and explore research aims related to identity. Designing a Toolbox instrument (Crowley & O'Rourke, 2020) as part of a research study could help guide the dialogue toward specific dimensions of the students' experience. Furthermore, applications of the Toolbox dialogue could be used across different contexts to better understand the experience of undergraduate students engaged in research. In addition, past studies (Leyva et al., 2021; Linn et al., 2015; McGee & Martin, 2011) indicate the need to create dialogue spaces for students from historically underrepresented backgrounds. The Toolbox Dialogue offers a methodology that could be used in those scenarios, prioritizing students' voices and potentially providing administrators and faculty with strategies to improve their programs.

Dialogue themes in context of literature about undergraduate research

A personal sense of discovery and curiosity were highly relevant to why students were conducting research, in line with research that has found these motivations to be salient for student researchers (Smith et al., 2014). The way that students view themselves as researchers has been shown to be intrinsically tied to both who they are (conceptual identity) and what they do (procedural identity) (Le et al., 2019; Urrieta, 2007). A significant body of work in UR highlights the value of research experiences

[5] Student in an engineering discipline who identified as mixed race and male
[6] Student in a life sciences discipline who identified as Asian and male
[7] Student in an engineering discipline who identified as mixed race and male

for the opportunity to progress professionally and develop skills to benefit one's career (Follmer et al., 2017; Junge et al., 2010). However, although they recognize its importance in this regard, students in this study did not view UR solely as an exercise in professional development. Undergraduate researchers in other contexts have also expressed this view (Marco-Bujosa et al., 2024). Furthermore, this study reveals that a single student may hold multiple and even at times conflicting motivations, which may be related to different aspects of their identities and values.

Social networks, academic standing, financial situation, and disciplinary identity were perceived as significant contributors to whether students are able to access UR opportunities, aligning with current research which acknowledges these factors as important accessibility considerations for UR (Pierszalowski et al., 2021). Social relationships in particular are critical to developing a sense of belonging in research (Graham et al., 2013; Huffmyer et al., 2022), and individuals from historically underrepresented groups especially seek out and benefit from community and social support (Carlone & Johnson, 2007; Marco-Bujosa et al., 2024). Interdisciplinary spaces may provide added opportunities for such communities. Mentors were seen by students as key supports to accessing and participating in UR opportunities (e.g., by telling students about opportunities and providing guidance). This finding is in line with previous literature which has demonstrated that mentorship is a critical relationship for undergraduate researchers which can especially affect participation and persistence for students from historically underrepresented groups (Aikens et al., 2017; Faber & Benson, 2015). As such, individual mentors can hold a great deal of power to support and uplift diverse student perspectives and their research pursuits.

Several students expressed feelings of discomfort based on a perceived culture that they didn't belong in their discipline or academia based on their identities. This particularly stemmed from anxiety about the relatively early point in their career. Students must navigate research environments by discovering who they are as researchers, the social and professional norms of their disciplines, and how their values and biases affect the way they conceptualize their role as researchers (Holland, 2001). When their identities are minimized or left unacknowledged, feelings of stress and self-doubt begin to emerge

(Carlone & Johnson, 2007; Le et al., 2019; Lu, 2015; Marco-Bujosa et al., 2024; McGee et al., 2017). Separately, students in this study described that engaging in research experiences that aligned with their identities and interests allowed them to persist in their disciplines, take pride in their accomplishments, and even expand their lab's research potential. To sustain their sense of self-efficacy, students draw on a sense of mastery and self-motivation (Trujillo & Tanner, 2014). Thus, mentors, universities, undergraduate research programs, and interdisciplinary learning can promote student confidence and mastery by acknowledging and affirming the diverse ways that their identities influence research.

Limitations and Conclusions

This study examined the ways that students articulate and negotiate their personal and disciplinary identities within peer dialogues about UR. Students were prompted to talk about the purpose of research, research outcomes, the research process, and how individual and collective identities shape research across disciplinary perspectives. By evaluating these conversations and the students' perspectives on identities in UR, our findings revealed that students are intentionally leveraging their personal identities to seek out and create research experiences that align with their goals and values. The interdisciplinary nature of the peer dialogues also encouraged students to consider the perspectives of other disciplines and examine their research from an outsider perspective.

Nonetheless, this study has several elements which should be considered when interpreting the findings. First, our study participants were limited to those conducting summer undergraduate research at a single university in upstate New York, USA, and the requirements of the UR programs further limited our pool of participants to those who were eligible, chose to apply, and were accepted. As such, it remains unclear how generalizable these findings may be for students in other national/regional or UR contexts (e.g., Course-Based Undergraduate Research Experiences; independent mentored research). Additionally, we acknowledge that there are likely key differences in individual student perspectives, as well as shared perspectives among students with shared identities, which were not examined in this study. It is well-documented that students from historically underrepresented backgrounds must consciously consider and navigate their identities in order to participate in research (McGee & Martin, 2011), while students with

dominant identities are not often asked to similarly consider the influence of their identities on the decisions they make. This examination of students from both dominant and historically underrepresented backgrounds across disciplines can thus be considered a strength of this work, as students from multiple backgrounds were able to explore their perceived roles as researchers together. However, other study questions and contexts may be more suited to discussions exclusively among peer groups with shared identities.

Overall, adding reflection points about the interconnected roles of identity and discipline can add value to interdisciplinary higher education. By creating explicit opportunities to develop understanding of self and others by exploring how different identities and experiences influence learning, interdisciplinary higher education can incorporate more explicit discussion and awareness of the role of multiple identity factors alongside disciplinary ones in students' choices of what to study and how they study it. This can contribute to the larger goals undergraduate students skilled in collaborative readiness for projects that demand interdisciplinary and interprofessional teamwork.

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Tables

Table 1. Participant Demographic Information

	2021	***2022***	***Subtotal***
Gender			
Male	12	12	24
Female	15	11	26
Non-binary	2	1	3
Did not respond	1	-	1
Ethnicity			
Asian/Pacific Islander	3	4	7
Black or African American	5	4	9
Hispanic or Latino	4	2	6
Native American or American Indian	-	1	1
White or Caucasian	13	7	20
Mixed race	4	6	10
Did not respond	1	-	1
Discipline			
Arts & Humanities	6	1	7
Engineering	3	2	5
Law		1	1
Life Sciences	8	9	17
Medicine and Health	2	2	4
Social and Behavioral Sciences	8	7	15
Physical Sciences and Mathematics	3	2	5
Did not respond	-	-	-
Number of years participating in inter or cross disciplinary activities			
<1	10	10	20
1-3	14	10	24
4-9	5	2	7
10-14	1	2	3
Totals	30	24	54

Table 2. Thematic Codes

Thematic Code	***Description***	***Subcodes***
Epistemology	Ways of knowing	Objectivity, Subjectivity, Self-Expression
Research Relevance	Relating to the relevance of the research objectives	Personal, Societal, Scholarship, Fundable
Ethics	Ethical responsibilities of researchers	Outcomes, Bias
Identities in Research	Seeking understanding about self to contribute to productively to society	Positionality, Access, Trust in self or others
Communicating Research	The purpose and/or process of communicating research and research findings	Ethics, Process or Objective, Feedback, Audience
Research Process	Practices in the research process	-
Mentorship	Student interactions with mentors or advisors	-
DEI Lens in Research	Using Diversity, Equity, and Inclusion (DEI) as a lens to interpret, assess, and understand research	-

Data availability statement

The interview transcripts generated during the current study are not publicly available to protect participant confidentiality but de-identified data are available from the corresponding author on reasonable request. Critical questions used in scripts and instruments underlying this study are openly available in the Toolbox Dialogue Initiative Center's Knowledge Commons CORE repository (DOI: 10.17613/vwf61-6pp50).

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Ethics statement

The questionnaires and methodologies for this study were approved as exempt by the institutional review board (IRB) of Michigan State University (Ethics approval number: Study #00005341, Approved 11/5/2020). All research was performed in accordance with the Declaration of Helsinki and all relevant guidelines/regulations applicable when human participants are involved.

Competing interests

The authors declare no competing interests.

Informed consent statement

Consent was obtained in written form through an online application from all participants on the day of the workshop they attended and immediately prior to their participation in the workshop (workshop dates: 14 July 2021, 21 July 2021, 19 July 2022, and 20 July 2022). Participation was completely voluntary and participants had the option to withdraw at any time, decline to respond to any particular question or

statement, or decline to participate in the dialogue. By providing consent, participants acknowledged that any data collected in this study could be used in research publications and presentations with all personal identifiable information redacted.

Author contribution statement

MAR, VI, and JH contributed to project conceptualization, methodology, project administration, funding acquisition, and supervision. MAR, VI, and KRS conducted data collection. All authors contributed to the development of the thematic coding scheme. KRS and JGV conducted formal analyses and wrote original manuscript drafts and contributed equally to the work. All authors edited and reviewed the manuscript.