education sciences

MDPI

*Article*

# Sense of Belonging, DFW Reduction, and Student Success: Centering Student Experience in Groups with Ethnographic Methods

**Jennifer Meta Robinson [1,*], Rachel Seymour [1], Seonmi Jin [2] and Rodney S. Whiteman [3]**

[1] Department of Anthropology, Indiana University, Bloomington, IN 47405, USA; rseymou@iu.edu
[2] Higher Education and Student Affairs, Indiana University, Bloomington, IN 47405, USA; jin15@iu.edu
[3] Office of School Partnerships, Indiana University, Bloomington, IN 47405, USA; whiteman@iu.edu
* Correspondence: jenmetar@iu.edu

**Abstract:** Despite substantial instructional attention to large-enrollment university courses in science, technology, engineering, and mathematics (STEM), they tend to have high rates of D, F, and Withdraw (DFW) at the introductory level that disproportionally disadvantage historically minoritized and underrepresented students, such as students identified as women, low-income, first-generation, or of color. While postsecondary institutions have recently explored big data and learning analytics to drive their institutional student success efforts, well-known shortfalls in student success in large STEM courses remain. This chapter documents an evidence-based approach at a large, R1 midwestern university that enriches robust data infrastructure with qualitative ethnographic methods. Applied to a gateway computer science course, these methods center students' day-to-day learning realities, including disparate educational opportunities, in ways that interrogate barriers to and shortfalls in student success. The resulting case study describes our ethnographic approach, the shortfalls it uncovers, our future directions with this work, and how other faculty members and institutions can apply lessons learned to promote efficacy, attainment, and equity in gateway STEM courses. Implementations drawn from course vignettes point to revisions in design and preparation of group learning activities, strategic integration of lecture and lab sessions, course navigation aids, and pedagogical training for teaching assistants.

**Keywords:** ethnography; strategic academic research; STEM; group learning; collaboration; course transformation; undergraduate teaching assistant (UTA); learning analytics; gender; equity; DFW



Academic Editor: Clara Sabbagh

Received: 31 March 2025
Revised: 18 April 2025
Accepted: 20 April 2025
Published: 24 April 2025

**Citation:** Robinson, J. M., Seymour, R., Jin, S., & Whiteman, R. S. (2025). Sense of Belonging, DFW Reduction, and Student Success: Centering Student Experience in Groups with Ethnographic Methods. *Education Sciences*, *15*(5), 523. https://doi.org/10.3390/educsci15050523



## 1. Introduction

*During one computer lab observation, I noticed a male and female student learning partnership that struggled to complete a collaborative coding exercise on a shared computer screen. The woman, "Rebecca", was reading out instructions from her own laptop to the man, "Tyler." Meanwhile, Tyler was rushing through what he assumed were the correct steps to the assignment without fully listening to her instructions. When the undergraduate student instructor noticed the inequitable partnership, he encouraged them to "share the work", emphasizing that the activity is like "sharing a gaming controller". Tyler reluctantly passed the mouse and keyboard to Rebecca, who began coding. However, Tyler was soon giving her detailed instructions on how to process the coding, saying things like "ctrl + C is copy", and "the 'parenth' goes there". After a few minutes of hearing these*

*detailed instructions, Rebecca chose to hand the mouse back to Tyler, who then finished the assignment for them both.* (Vignette 1, Lab B fieldnotes, 27 January 2022)

This exchange, documented by a trained ethnographer in an introductory computer science lab, provides a rare glimpse into student participation in group learning at the point where instructional design meets social dynamics. Instructors and students, alike, may hope that including best teaching practices, such as group learning, a form of active learning, will foster cooperative collaborations and greater student learning; however, our research shows that, in practice, a host of factors at this social–instructional intersection—including academic preparation, social expectations, and instructional decision making—can instead create new barriers or reveal existing challenges to student learning.

The stakes are particularly high in gateway courses, which are foundational, credit-bearing courses serving as prerequisites or entry points into academic majors and career paths. In addition, some gateway courses have high D, F, and Withdraw (DFW) rates, and students may believe that instructors design large science, technology, engineering, and mathematics (STEM) gateway courses intentionally to "weed out" weaker students, as one of our student interviewees said. The result is an exclusionary reputation for these courses (for example, Malcom & Feder, 2016). In fact, many gateway courses tend to have disproportionally higher DFW rates for historically minoritized and underserved students, such as students of color, low-income, first-generation, and women (Alexander et al., 2009; Hatfield et al., 2022). For these students, lower success rates mean these courses can obstruct their entry into related majors in sciences, healthcare, and technology, and too often prevent even promising students due to inequitable social dynamics experienced during group learning sessions, as this chapter goes on to discuss.

Recognizing the barriers that gateway courses can create for diverse students pursuing STEM majors, universities have invested in instructional methods and assessments intended to keep the gates open. For example, instructors add small-group learning experiences, such as partner work, discussion sections, and labs, to attempt to mitigate learning challenges associated with large lecture instructions. However, quantitative measures on which learning assessments may rely (e.g., outcome data and statistical models) are not designed to capture the nuances of what happens during small-group learning experiences or how peer-to-peer social interactions lead to downstream disparate DFW outcomes. This black box between small-group instructional interventions and DFW outcomes invites textured inquiry into student experiences within these interventions that situate students in social–instructional intersections.

This chapter develops a case study on the application of ethnographic methods to understand the operations of small-group learning on STEM gateway courses with high DFW rates. It proposes to supplement a large public university's outcomes-based, quantitative institutional data with qualitative approaches that refocus our attention on small-group interactions where practice with learning is assumed to happen and that highlight important social context for learning, such as belonging and equity. In other words, we interrogate how social dynamics in group learning reproduce inequitable learning outcomes among student populations with different senses of belonging. Thus, students with greater social resources in the larger society benefit from that status in an educational institution and also in smaller learning settings. Scholars have called for examining classroom experience based on values and dispositions that minoritized students have, which are often neglected by the dominant populations (Gay, 2018; Howard, 2003; Ladson-Billings, 1995; Yosso, 2005). Thus, we attended to cultures and practices, especially in terms of race and gender. More importantly, we move from uncovering social dynamics in small groups to improving group design and, potentially, to improving learning. In this way, we counter a deficit-based understanding of learning by centering an equity-conscious one. This study

contributes to this volume and the larger conversation on strategic academic research and development by proposing strategies for a more complete picture of the layered realities of classroom learning experience that can be made visible through a diversity of methods, both quantitative and qualitative.

## 2. Review of Literature and Theory

This study sits at the intersection of three areas of research: statistical learning analytics, small-group learning interventions, and sense of belonging, all set in the context of STEM gateway courses. We begin with an overview of the possibilities and limitations of understanding DFW rates with statistics, and follow that with a discussion of alternative, qualitative methods for investigating student experiences in gateway STEM courses. Our review of small-group learning interventions on DFW outcomes leads us to discuss the larger, cultural effects on the student experience at the levels of lectures, labs, and groups. Finally, we review major publications on students' sense of belonging in STEM educational settings.

### *2.1. Possibilities and Limitations of Understanding DFW with Statistics*

The dynamics of student success and failure in higher education are complex enough that even the most informed college teachers may not be well positioned to observe and understand them, especially as course design becomes elaborated with small learning groups and multiple technology modes. While recent developments in learning analytics offer insights into student success, such data sets are unevenly available to faculty for application to their course and curriculum decisions (Baepler & Murdoch, 2010; Dunbar et al., 2014). In addition to the data access, faculty have uneven preparation and self-efficacy regarding collecting and analyzing student data analytics, differing confidence in the value of student data for improving learning, and the feasibility of collecting and using it to improve teaching, and to undertake such study, instructors "must believe that the benefits of the gathering and use of student data outweigh the amount of effort required to follow through with the process" (Svinicki et al., 2016, p. 6).

More importantly, a consequential information gap exists in the interpretation of learning analytics, particularly regarding the social environment in which learners are situated. Even as course learning analytics become more available through dashboards and other tools, faculty do not necessarily find the data useful, persuasive, or organized in an actionable way to benefit diverse college learners (Ali et al., 2012; Buerck & Mudigonda, 2014; Ferguson, 2012). Indeed, many data dashboards and institutional data reports are designed to understand factors that help run the business of the higher education institution rather than support classroom instruction. Traditional learning analytics and data dashboards lack the richness needed to fully support instructors in their pedagogical decisions (Oblinger, 2012). To address this gap, instructors would benefit from thick records—descriptive data that provide depth by offering context, meaning, nuance, and human experience that learning analytics were never designed to capture or convey.

While some studies connect learning analytics to course content and environment in ways that can impact the structure and evaluation in large lecture courses, including identifying patterns of gendered student performance (Matz et al., 2017), these methods can be less thorough in describing social–instructional dynamics in the small places of these courses. Moreover, while "action analytics" has been proposed as a rapid response to patterns revealed through statistical analysis, whereby teachers, students, and advisors "can make smart choices to influence learning" (Norris et al., 2008, p. 1), much of the literature focuses on aligning students' decisions with predictive statistics (Desouza & Smith, 2014) and "optimizing" macro-indicators of educational success, such as retention to the third

semester or time to degree. Nevertheless, combinations of representative or revealing student cases combined with qualitative pattern finding have long intrigued instructional designers. For example, the Analysis, Design, Develop, Implement, and Evaluate (ADDIE) instructional design process (Molenda, 2003) suggests that an instructor, after designing and teaching a course, can view it anew through relevant data to create an evidence-based revision. In a sense, this combination of design and practice with qualitative and quantitative data powers up the sort of quick assessment that many faculty conduct already with GPA distribution and student evaluations of teaching (Dunbar et al., 2014).

### 2.2. Investigating Student Experiences in Gateway STEM Courses

Institutions of higher education have used student evaluations of teaching (SETs) as one tool to access and assess student experiences. We do not intend to critique SETs in this paper by arguing they are inherently flawed or limited by internal methodological weaknesses (see Constantinou & Wijnen-Meijer, 2022; Spooren et al., 2013). However, we do suggest that SETs were never intended to capture the complex, day-to-day classroom experiences and interactions students encounter. In fact, SETs have evolved to be used for three primary purposes: improving teaching quality, input for tenure/promotion decisions, and providing evidence of institutional accountability (Spooren et al., 2013, p. 599). To serve these purposes, Richardson (2005) also asserted that SETs "usually consist of standardized questionnaires (including both rating scales and open-ended items) aimed at providing a descriptive summary of the responses for both the teacher and the teacher's department head, as well as the institution's educational board or personnel system" (Spooren et al., 2013, p. 602). SETs do not capture rich experiences and dynamic data as they unfold in the classroom environment in real time and in their full context, and they were never intended to.

Ethnography offers a theoretical and methodological approach that captures both unique and shared experiences of people in social settings, including formal and informal educational institutions (Mead, 1928; Miner, 1956). An ethnographer's "deep hanging out" in these spaces, a term of art that suggests immersive and sustained participant observation through informal, everyday interactions, gives them the potential to develop a nuanced, insider perspective on a community (Geertz, 1998). This long-term engagement allows them to describe social dynamics, cultural practices, and local meanings through methods, such as participant observation, interviews, focus groups, and other qualitative approaches, that elicit deeper participant responses (Bernard, 2011). For education, ethnography offers a humanistic lens to understanding the challenges students face (Kirner & Mills, 2020). By gathering individual-scale "small data" from the "small places" (Eriksen, 1995) of educational life—courses, labs, modules, and lessons—ethnographers can help identify levers through which student learning can be catalyzed. Instructors can then use such information in their teaching design of particular courses and for their particular students. In this way, ethnography aligns with theories of knowing as social, culturally, historically, and contextually mediated, such as cultural–historical activity theory (Iloh & Tierney, 2014).

For decades, educational researchers have applied ethnographic methods to understand the cultures of schools and colleges, moving discussions about learning away from intrinsic and psychological analysis (e.g., of motivation or development) into the observable, social realm (see, for example, Carspecken, 2005; Delamont, 2012; Foley, 1990; Iloh & Tierney, 2014; Willis, 1981; Wolcott, 1973). Susan Blum's (2016) application of the practice revealed that college students navigate two unreconciled narratives: they love learning yet find conventional college education confining and unrelated to their learning goals. Ethnography continues to offer an important window into the paradoxical practices and experiences posed to students, increasingly important as college demographics

and preparation diverge from prior generations (Hinton et al., 2020), putting further distance between what was documented to work before and what may actually work now. Resolving such dissonance is especially important given that the persistently negative experiences of cultural marginalization and educational opportunity for minoritized communities (Gillborn, 2010; Teranishi, 2007) can be reified in educational environments, design, and pedagogy (Hooks, 1994). Ethnographic descriptions can aid such efforts by capturing detailed social dynamics in small learning groups that replicate privileges and power prominent at larger levels of social organization (Bourdieu, 1970). These descriptions can better illuminate patterns of equity and inequity, belonging and exclusion, in ways that can be used to motivate strategic changes to learning design (Davis & Saunders, 2022).

### 2.3. Small-Group Learning Interventions into DFW Outcomes

In response to disparate and high DFW rates made clear in learning analytics, and in recognition of how these rates and other data can predict students' academic performance, universities have adopted small-group learning interventions to narrow performance gaps in large courses. University teaching, learning centers and new publications continue to promote the efficacy of small-group learning (e.g., team-based learning by Michaelsen et al., 2004). Learning in small groups—which variously emphasizes collaborative, cooperative, cluster, group, or team activities—has been widely embraced as an educational best practice in STEM in higher education since the 1970s (Davidson et al., 2014; Johnson & Johnson, 1989; Slavin, 1996). STEM fields, including computer science, are no different, with instructors adopting small-group learning to complement large lecture-based courses (Caceffo et al., 2018; McConnell, 1996; Pirker et al., 2014).

Indeed, small-group learning invites several key technical, social, and learner-centered features that make it attractive to universities. Technically, group learning is characterized by learners' active participation, engagement in a specific task, and reflective learning (Jones, 2007). Small-group learning is assumed to leverage the social nature of learning, with the goals to mimic the way professionals work, introduce diverse perspectives and people, activate critical thinking, improve communication skills, reduce anxiety, and increase student-centered responsibility (see, for example, Springer et al., 1999). These characteristics situate students to engage with the group learning materials from their own perspectives. Evidence suggesting that small-group learning can have positive effects on historically minoritized students' outcomes in STEM courses has further encouraged universities to take up the practice (Cohen, 1994; Freeman et al., 2014; Theobald et al., 2020).

### 2.4. Cultural Limitations to Small-Group Learning Effectiveness

However, teachers and scholars have long recognized persistent and significant challenges in conducting effective and equitable learning in small groups (see, for example, Cohen et al., 1999; Slavin, 1996). Not least, small groups are not hermetically sealed social situations but partake of the larger social dynamics, inequities, and power differentials of the larger world in which they sit (Cohen et al., 1999; Ochoa & Robinson, 2005). Difference in group members' demographics, discourse, and interaction styles factor into the success of group learning activities (Cohen, 1994). Moreover, differences in socio-demographic status can create communication challenges within these groups (Cohen, 1994), influenced not only by the identities and status of undergraduate peers but also by those of peer tutors, graduate teaching assistants, professors, and others involved in the learning process.

The effectiveness of group learning for women students is particularly salient for our findings, although to a varying extent. For example, Kinzie et al. (2007) found that the classroom climate regarding women's education—whether it is taken more or less seriously—can mediate the experiences and educational outcomes of group learning for

female students. The authors also elaborated that institutional and classroom climates can be replicated in small learning groups. In other words, the effectiveness of small-group learning can vary depending on the larger contexts surrounding the classrooms. In this regard, while some have found positive effects (Fong et al., 2024; Sax, 1994; Wilson & Varma-Nelson, 2016), Jin et al. (2020) revealed mixed findings. They found that, in a collectivist culture like South Korea, group learning was not as effective for female students, compared to its positive effects for male students, in fostering students' aspirations to remain in and contribute to STEM disciplines. The authors suggested that female students were often placed in groups where male students were overrepresented, leading to and reinforcing their isolation from female peers in the classroom. Furthermore, group learning could even perpetuate dominant disciplinary norms and stereotypes of women in STEM. Therefore, small-group instruction cannot be a panacea to solve inequity in educational experiences unless it is implemented with attention to social dynamics in groups, the classroom, and the institution.

Operationally, scholars have argued that the lack of teaching practices that reflect the cultures of minoritized students has stagnated efforts to resolve the inequity that persists in student outcomes (Gay, 2018; Howard, 2003; Ladson-Billings, 1995). Gloria Ladson-Billings (1995), in particular, asserted that researchers should attend more to speech and language interactions in classrooms that underscore how the cultures of dominant vs. minoritized groups frame and value student learning. For example, Black students in STEM majors emphasized communicating a communal orientation during group learning, valuing individual contributions to organizing and maintaining the group (Priddie, 2021). Furthermore, students of color learn more effectively when their strengths align with the cultural values of their communities of color, such as navigational, aspirational, and linguistic capital (Yosso, 2005). McGee and Bentley (2017), in their empirical study, also found that high-achieving Black and Latinx students in STEM majors were driven by strong equity-based ethics, which entails their concern for helping others, social justice, and equity, shaped by their cultural values of racially minoritized communities. In other words, instructors should systematically design, monitor, and intervene in learning groups to ensure culturally relevant interactions take place.

To contextualize and to frame cultural limitations to small-group learning effectiveness, we turn to the literature on educational equity, specifically ways in which students' sense of belonging is related to classroom environments, small-group learning, and learning outcomes.

### *2.5. Sense of Belonging and Educational Inequities in STEM Fields*

Sense of belonging was identified by early theorists as "a feeling of connectedness, that one is important or matters to others" (Rosenberg & McCullough, 1981). It has come to emphasize students' social identities (e.g., race, ethnicity, gender, sexual orientation) and the ways in which minoritized social identities are overtly and covertly excluded, made to feel unwelcome, made to feel like they or their contributions are unimportant or fundamentally impoverished, and ultimately pushed out of higher education. Terrell L. Strayhorn (2018) expanded the original definition of belonging to include how historically marginalized college student populations perceive social support on campus. We have taken up sense of belonging as a conceptual lens to better understand social–instructional dynamics in this computer science classroom. The very nature of small-group learning in large classroom settings makes it difficult to monitor and intervene in groups where gender, racial, or cultural bias occurs, such that students are made to feel unimportant or undervalued. Left unacknowledged and unchecked, minoritized students' sense of belonging may be undermined, discouraging them from pursuing or advancing in these

disciplines, particularly in STEM (Kennedy et al., 2023; Janke et al., 2024). Belonging hinges on feelings of connectedness, mattering, and being cared about, accepted, respected, and valued by the campus community, including faculty, staff, and peers (Strayhorn, 2018). Other studies indicate that seeing instructors and peer students who reflect one's own demographics contributes to a sense of belonging (Brooms, 2020; Hurtado & Ruiz Alvarado, 2015). What is salient is that students' sense of belonging in gateway and other introductory courses is crucial because it fosters a connection and a claim to rightful presence (Calabrese Barton & Tan, 2020) in STEM disciplines and careers, which can encourage perseverance through challenging coursework and content (Hausmann et al., 2007).

In computer science, women and racially underrepresented students have reported a lower sense of belonging compared to men and white students (Master et al., 2016; Mooney & Becker, 2020; Mooney et al., 2020; Moya et al., 2023). Studies have corroborated that inclusivity and equitable design in instruction improve sense of belonging of underrepresented students in the field, shaping student learning experiences positively by helping students to challenge stereotypes and build computer scientist identities (Koch & Rodier, 2014). Developing a strong sense of belonging for underrepresented students in computer science gateway courses can be critical. Because these courses are literally gateways opening or barring access to majors, to degree programs, and ultimately to career paths (Koch & Rodier, 2014), their disproportional DFW rates create significant barriers for historically minoritized populations, including students of color, women, transfer students, and undocumented students in STEM courses (Koch, 2017).

However, social, cultural, and political inequities that pervade institutions of higher education are also present in gateway STEM courses and small-group instruction within those courses. In institutions that are historically and predominantly white and in courses constituted by predominantly white institutional structures (PWI), instructors, often unknowingly, may reinforce biases and privilege, which can seed the ground for gender, race, or cultural bias incidents in small-group learning. Institutionalized structures can (re)create rigid structures and limited opportunities to demonstrate learning (e.g., reliance on memorization and standardized testing) and devalue skills, knowledges, and cultural wealth minoritized students have successfully developed and deployed across their lives (Hooks, 1994; Yosso, 2005). Thus, we argue that university educators should attend to how students experience the learning environment, even in small-group settings, and shift these social dynamics to the foreground—from the implicit to the explicit—to identify if or how these social–instructional settings promote or frustrate students' sense of belonging and to provide actionable and meaningful interventions that promote success for all students in these courses. In what follows, we describe how we took up ethnographic research methods to answer that call.

## 3. Context, Design, and Methods

This study began in Spring 2022 as a collaboration between a computer science professor and a team of educational anthropologists. The course professor had conducted extensive statistical analysis, resulting in iterative course revisions, yet high DFW rates remained intractable. He was motivated to further study by a persistent question: What do the statistics not show about why high numbers of students—especially women and other underrepresented students—struggle, fail, or withdraw from this course required for the major? According to the university's office of institutional analytics, which derives course analytics from enrollment data, immediately previous to the study, in Fall 2021, the combined two sections showed DFW rates of 39% (of 134 total students). Moreover, during our data collection semester, Spring 2022, the DFW rate in the lone section climbed to 66% (of 41 students). Importantly, women, already a minority of 18 among the 134 students,

withdrew at a rate of 39% in Fall 2021, while 48% of all first- and second-year students withdrew. The study designed by Jennifer Meta Robinson and Rachel Seymour in response to these conditions, particularly, attends to how course structures create barriers to student success, with a focus on perceived belonging. It was approved as Indiana University Institutional Review Board protocol # 13901.

In keeping with ethnographic methods, our on-site ethnographer, Seymour, attended twice-weekly lectures in Spring 2022 that were taught by the computer science professor, and she rotated her attendance each week among computer labs taught by undergraduate instructors. During these lectures and labs, Seymour conducted participant observation that focused on writing down, in narrative form, what she saw as important moments in understanding the social–instructional context of large- and small-group interactions, bringing both self-awareness and third-person perspective to describing phenomena. This narrative documentation is called fieldnotes, and it may include observation, participating while also observing ("participant observation"), interview highlights, vignettes, or rich point development, talking with people involved or not involved, casual conversation, behaviors, settings, and so on. Influentially developed by Bronislaw Malinowski (1915) during his research in New Guinea, fieldnotes help ethnographers to document and synthesize their work. As early as 1887, Franz Boas (1887) was beginning to orient the method not just toward a record of observations but also to include reflections, critical analysis, and interpretation of culture. In the present case, the ethnographer supplemented her observations with the variety and depth provided by both semi-structured interviews and informal chats that included some of the same questions, as well as with one focus group of students in the course who were recruited after attending course labs. This ethnographic approach, common to anthropology and other fields, allowed the ethnographer to narratively render vignettes that form the basis of our findings.

This study is based on one semester of observation in the computer science course, designed by an ethnographic team (Robinson and Seymour). The focal course, an introduction to computer science, introduces students to a variety of computing and programming systems in order to teach principles of systematic problem solving, teamwork, and other career skills. The professor (the instructor of record) does not assume any programming experience and intends the course for both majors and non-majors, supporting them with labs staffed with undergraduate teaching assistants (UTAs) and structured with collaborative assignments. UTAs act as peer leaders supporting students' group learning. No graduate-student instructors are used in this course. The course is one of only two options required for upper-level courses in the major and relies on a less intuitive programming language. Additionally, it uses a complex coding theory compared to the other course. While students may gravitate toward this course and this major to secure financial and social capital in a variety of technical careers (National Center for Science and Engineering Statistics), taken as a whole, the course presents them with some unusual challenges. The course uses the standard Canvas (Sakai) course management platform and a custom ("legacy") website while also offering additional supplemental resources, and an external Discord discussion forum. Students work extensively in collaborative teams that may include people quite different from them in academic preparation, gender, and ethnicity. Moreover, teamwork was new for most CS students we talked with, who were used to completing assignments individually.

Other financial, structural, and environmental factors shaped the course. In response to current budgeting models, the lab sections are led by undergraduate instructors, most with little teaching experience. Additionally, the target semester for observation was during the COVID pandemic years. The Spring 2022 observation semester presented additional institutional barriers, social challenges, and healthcare concerns while the COVID-19

Omicron variant pandemic was at its apex. Like others, faculty in this course responded by offering a back-up option to view recordings of lectures when health conditions warranted. During this semester, attendance in lectures and labs seemed to dwindle, with 39% of enrolled students receiving D, F, or W, as we will explain further below, with ethnographic and statistical observations.

### 3.1. Data Collection

In Spring 2022, Seymour attended eight lectures and ten labs. Lecture sessions were held twice a week, in person, and were posted online as video recordings to accommodate COVID and other illnesses. Although we are referring to "whole-enrollment meeting times" as "lecture" periods, in fact, about half the meeting time was typically centralized on the professor going over the coding lesson, while the other half was spent in active learning exercises in assigned teams of 3–5 people, during which students checked their understanding of complex theory. This insertion of group work into what is classically called "lecture" class meetings is an example of the efforts of many STEM faculty to include active learning as a best practice. "Lab" sections, on the other hand, were held once a week, in person, with no online option. Three lab sections were taught by UTAs who previously succeeded in the course. In the lab, students must complete their coding assignments in 2 1/2 h, sometimes in self-selected partnerships with a maximum of two other people. In addition, Seymour conducted one in-depth, semi-structured interview with a white man after the second midterm, and one 25 min, semi-structured focus group ($n$ = 6). The focus group comprised five white male students who were invited to join after attending a lab where they sometimes partnered for collaborative work. They had the following aggregated characteristics:

- Level: three first-year students, one third-year, one fifth-year, and one graduate student.
- First-generation students: one
- Required courses for their major: four
- Required courses for their minor: two
- First time taking a computer science-related course: three
- Attended lecture weekly: four
- Attended labs weekly: six
- Used the chat function on Discord to talk to a UTA or Professor: five
- Attended office hours for a UTA or instructor: one
- Attended tutoring.

As a final input stream, she collected an intake Qualtrics survey at the beginning of the semester, which was not analyzed because of an insufficient response rate ($n$ = 14).

### 3.2. Analysis

We used ethnography as both an investigative and analytic process to study the cultures and communities of the target course. By observing and interacting with people in their everyday environments, our ethnographer was immersed in the places and practices of students' daily lives. By analyzing her recorded observations, the larger team gained an understanding of students' behaviors, beliefs, and social dynamics. We especially attended to rich points during which expectations about social dynamics were not aligned, suggesting a meeting of different ideologies (Agar, 1980). From the array of rich points collected, we identified patterns among them that point to common and important issues of learning and success in the course. We focused on group and partnered activities, a best practice for student belonging that also teaches an important computer science career skill. Moreover, we attended to issues of scale, in which microcosms in a classroom reflect

macrocosms in culture, and vice versa, allowing for analysis that acknowledges social and cultural structures threaded through and influencing social–instructional interactions.

Ethnographic analysis often renders rich points as short, descriptive narratives during the research. These vignettes serve as illustrative examples that bring the data to life, providing readers with a vivid sense of the context and experiences of the people being studied. They can provide illustrating themes, context, social intersectionality, humanizing information, and supporting analysis. Vignettes bring distinct value to qualitative research, particularly for making sense of extensive data collected over time or by multiple researchers. They allow researchers to craft meaningful representations of complex experiences, sometimes presented as composite narratives when no single example fully encapsulates participants' experiences or what researchers aim to express (Spalding & Phillips, 2007). Instead, researchers can draw on fragments that recur with enough impact to credibly illustrate important themes or dynamics. Through this process, crafting vignettes is both a reflective, recursive analytic technique and a means of authentically (re)presenting data and findings to readers.

When crafting vignettes by attending to readers' needs for understanding, sensemaking, and trustworthiness, we necessarily invoke questions of validity. We understand validity to be "the reasons we have for believing truth claims" (Moghaddam, 2007, p. 236), which we assert throughout this chapter. From this perspective, validity in this study is no different than validity in any other rigorous study. We have collected data systematically; processed it and analyzed it systematically, recursively, and reflexively; discursively reached conclusions about the data relative to the research questions; and then presented the data in ways that are attentive to our understandings of the study participants, of ourselves as researchers, and of our readers within the context of this particular publication and medium. These considerations align with what Barbara Dennis (2013) calls "ordinary validity".

### *3.3. Using Vignettes to Make Meaning of Students' Social–Instructional Experiences*

Our decision to craft vignettes contributes to ordinary validity by responding to readers' needs to make sense of the interactions we captured in our data. By compiling these pieces, vignettes provide recognizable and compelling depictions that resonate with readers. The vignettes we present here evoke questions of culture and belonging in learning teams that are related to successful progress through the course by realistically and recognizably (re)presenting factors foregrounding the multidimensionality of the social–instructional setting of this introductory STEM course. Like all stories, vignettes help people make sense and meaning of their experiences and share those experiences with others (Clandinin & Connelly, 2000; Mertova & Webster, 2019; Riessman, 2008).

Isolated instances within qualitative data may be dismissed by some as outliers or "one-offs". However, through vignettes, these singular moments are distilled into coherent narratives that are harder to ignore, inviting readers to consider their accumulated significance within the broader context of participants' experiences (Ely et al., 1997). Rather than isolated instances, our vignettes were chosen and crafted from rich data to be illustrative of patterns and themes we discerned through our conceptual lens. They convey realistic, meaningful examples that point to complex experiences (Ely et al., 1997), and we invite readers to consider the significance of these stories within the broader context of student social–instructional experiences within this computer science course.

## 4. Findings

Ethnographer Seymour's attendance in learning settings allowed us to identify several areas of tension in the computer science course that might create obstacles to student

learning, which we summarize in six findings. Each finding contains illustrative vignettes, snapshots captured from Seymour's field notes, semi-structured interviews, and a focus group of students in the course.

### *4.1. Finding 1: Gender Inequity in Small-Group Settings*

The introductory vignette (see the first passage on page 1), in which a South Asian man and a South Asian woman navigate a collaborative project, illustrates that gender inequities can be subtle but pervasive. As a generalization, groups with a majority of male students or a dominant male work partner tended to socially dominate their lone female teammate in ways that limited the role of idea production to men. In intervening in such biased group dynamics, female lab UTAs, especially, can be effective in supporting other female students. For example, when a female student said to one, "I'm normally so good at math, why don't I get this?" the female UTAs were highly encouraging, saying, for example, "Keep it up. It will come to you with time. It just takes some practice. You got this!" (Lab B, 10 February 2022). Since the UTAs have taken the course before, they may recognize struggling teams and know how to redirect struggling groups; however, those skills are not pervasive and can be strengthened with training.

### *4.2. Finding 2: Racial Inequity in Small-Group Settings*

Racial inequity is visible in small groups. Based on our observations, students of color and specifically women of color speak up less when they are few or singular in a group of all white students or all white male students. For example,

> *During the lecture, five students were grouped together for active learning time: three white male students and two students of color (one male and one female). During this activity, students were given a worksheet to complete as a group and discuss the answer before turning it in to the professor. This group chose to huddle around the single female student in the group and designated her to perform all the writing duties for the activity. During this time, all three white male students spoke up and discussed their opinions on how to complete the activity, while the two students of color remained silent. When it came time to write the agreed-upon answers, the white male students coached the South Asian female recorder by pointing at the paper, directing what to write, and even saying, "you can erase that", when she added her own ideas.* (lecture fieldnotes, 28 February 2022)

As this vignette illustrates, when women, white and of color, are incorporated into a group of white male students, their role may be determined as service work, such as recording notes, synthesizing silently, and following directions. Moreover, a woman of color experiences race and gender intersectional inequities that doubly limit her voice and learning.

When students of color are grouped for an exercise, which in this course they frequently were, they can be less socially engaged than white male groups. This lack of visible social engagement can allow groups of students of color to finish their labs early while white male students socialize. However, what the early groups gain in time, they may sacrifice in fewer social bonds to retain them in the course, less time on processing, questioning, and revising, and smaller educational and professional networks. Moreover, conversations about course content, social occasions, and other general topics decrease in mixed groups like the one in this vignette. However, in lectures, the ethnographer also observed some students of color managed to break into white male-dominated conversations, and some became group leaders who excelled at the material.

### *4.3. Finding 3: Membership Structure in Small-Groups Settings*

Students were assigned to groups in lectures at the beginning of the semester based on last name and pronouns chosen on the course management platform in an effort to demographically diversify groups, while in labs, students chose their partners. Student attrition and nonattendance required recombining groups throughout the semester, as observed in the following two vignettes:

> *A Black student from an unstructured interview in week 5 told me he dropped the course the prior semester because he was unaware of what he needed to do to succeed. During his first semester in the course, he attended lectures every week and, early on, made connections with the small group he was assigned to collaborate with in lecture. He enjoyed the teamwork. However, after the first midterm, fewer team members showed up for lecture sessions, and his group was consolidated with another. He began to feel the loss of the group members he had come to know. After the second midterm, attendance continued to drop, and his small group was again recombined. He eventually became discouraged by the changes and dropped the course. During his second attempt at the course, he told me that he decided to spare himself the frustration of losing small group members by not attending the weekly in-person lectures at all. He said, "I would come in each week and get a different group member. It was frustrating each week knowing that I might have a new set of partners, and I do not feel like group work is worth going to since it is not new material [to me, having taken part of the course before]"*. (Lab B Interview, 10 February 2022)

Similarly, the ethnographer noted the following in the partner dynamics unfolding in a lab:

> *One female student decided to stop collaborating on the lab and work ahead of her female partner. As a result, her partner sought help from another group. The student explained to her new partners that she felt lost because her former partner was ahead and refused to help her, simply telling them, "I don't know what to do, can you help me?" While this was transpiring, no UTA intervened*. (Lab C fieldnotes, 11 February 2022)

As illustrated in these two vignettes, the course design is intended to foster community and learning by having students work in collaborative teams and pairs during both lecture and lab meetings. Moreover, inequities of privilege, power, preparation, and commitment may occur among group members. Indeed, the participant–observer saw gender- and race/ethnicity-based inequities during group work in both labs and lectures.

Students who do not participate in groups consistently miss opportunities to practice course concepts as well as to create learning networks that may help them in this and future computer science courses. While diversity among teams is generally considered a strength of the group-work pedagogy, instructors should prepare students to work productively in groups and also monitor their success during the group process. Moreover, cultural differences between students—in terms of roles and expectations—may be more difficult to overcome in the short span of a semester.

### *4.4. Finding 4. Sense of Belonging in Small-Group Settings*

The following two vignettes illustrate our perception that student teams worked well based on the sense of belonging they fostered:

> *"Student 6" in the focus group expressed frustration regarding the lack of attendance in lecture group activities. He still attended weekly lectures, he said, only because he and others had committed to "attend everything for the course"*. (Focus group, 24 March 2022)

Similarly, here:

> *Students who were consistent with lab partner work were also more likely to show up for lectures and participate in partner work there. These students seemed to build positive interpersonal interactions through these partnerships*. (Focus group and interviews, 24 March 2022)

The first vignette, involving Student 6, addresses how the power of commitment to oneself and others can be motivating. In it, the student, who, along with others, was recruited after he attended a lab, supports our observation that some students were attending lecture and lab sessions consistently and that their learning was disrupted by those attending more intermittently. The second quote is from the ethnographer's fieldnotes. Fieldnotes are documentation of the ethnographer's participant observation, including moments, impressions, quotes, casual conversations, behaviors, and so on. In this case, the second quote in Finding 4 is the synthesis of gathered observations, interviews, and focus group comments. It illustrates a third-person perspective on how consistent attendance and participation can support relationships that foster learning. The ethnographic fieldnote demonstrates that belonging is in dynamic tension with consistency, pointing to significant, interdependent skill sets, suggesting that students able to manage one may have better outcomes for the other.

### *4.5. Finding 5: Lack of Knowledge of Course Structure*

As late as week 11 of 16, a student in the focus group who admitted they did not regularly attend lectures agreed they could not entirely explain the central coding process required for the course, the course's Design Recipe, even though they said they were taking this introductory course over others specifically to learn this complex theory that would benefit them in later courses and future computer science careers.

> *"I just thought like, 'Oh, this is just something they are trying to teach us, or whatever!'" Because, like, you can, you can still do this stuff without doing the Design Recipe. Like, you can have the basic function. But, like, I think using it is, like, really important, especially like when it comes to, like, the further lessons and stuff. Like when we're working with, like large datasets, and doing, like, more advanced functions, it definitely works, right?"* (Focus group participant, 24 March 2022)

In this vignette, the students referenced a measure of luck or black box processing, as articulated by a student who said, "sometimes they just put the template together and run the code, and it works". The abundant use of the word "like" helps to unpack this moment as an Agarian rich point. That the word "like" is repeated points to its phatic rather than informational usage (Malinowski, 1923; Jakobson, 1960; Bauman, 1983). That is, it offers social meaning that connects the speaker to their interlocutors in specific ways, not necessarily referentially. In this case, "like" may be a filler word, or filled pause, that manages the rate of speech, including affording the speaker time to gather their thoughts before moving on with more information (Schiffrin, 1986). "Like" may also indicate a "hedge" on the part of the speaker, reflecting their lack of complete certainty about their statement or softening what may sound like a definitive opinion into a tentative thought to maintain social relations (Seals & Coppock, 2022). Similarly, the question "right?" may here be a phatic move that seeks assurance and inclusion from others on a topic of uncertainty. Most concerning was how late in the semester this student recognized that the coding "recipe" was an important step-by-step process for writing readable, high-level code correctly—perhaps too late to serve them well—even though they attested to being a regular attendee at lab sessions. The students who do not attend lectures and/or labs are

missing opportunities to build their understanding of such essential course material as the Design Recipe and may, thus, find themselves outside the classroom community.

The vignette shows that missing lectures prevented students from developing an understanding of core concepts and consequently from playing contributive roles in the group learning sessions. More than just presenting and interacting in a group, research shows that students' collaborative contribution to group learning is appreciated among Black students (Priddie, 2021). Similarly, students who are racially minoritized with collective cultural values might have unsatisfactory experiences in group learning sessions. Such negative experiences can cause a decreased sense of belonging, inequity in the group work contributions, and guilt in not being able to contribute to the group work meaningfully (especially students with stronger dispositions for collective values).

### 4.6. Finding 6: Workflow in Small-Group Settings

Some students really enjoy the interpersonal nature of labs, but others may feel they are "too distracted" and "cannot finish on time" if "socializing" seems to be a required part of working with someone.

> *A student told the me that he is spending up to 2 h before labs to prepare half the exercises intended for in-lab completion so he can finish everything by the end of lab (for a total of 4½ h of lab work instead of 2 1/2). As a result, assignments intended to require partner work are done individually. Students coming to lab intending to work with a partner as instructed find many people are already halfway finished and reluctant to either wait or help them catch up. Although many students enjoy partner work, this student and others were frustrated or resentful at not having enough time to complete the lab or develop partner work as assigned*. (Interview with student, 24 March 2022)

The students in this vignette find lab time is not enough to finish assignments even without socializing. Moreover, the focus group members said they worked alone outside of formal course meetings to prepare for assignments and exams, instead of activating their teams. The choice to work alone, even on assignments designed for groups, suggests that collaboration may be gratuitous and expendable, especially when time is short. Students who want to complete the work as instructed can be frustrated and resentful to have seemingly unnecessary components that slow them down.

These six findings point to implications about students' sense of belonging during this gateway course and, by implication, others that end-of-course evaluations may not expose.

## 5. Discussion

In what follows, we discuss the implications of our findings and the form in which they were reported to the computer science faculty. From there, we address the short- and long-term outcomes associated with the interventions based on that report, the limitations of the study, and directions for future research.

### 5.1. Implications

Drawing on the findings from the qualitative data, overall, we offer four implications, each addressing multiple challenges at intersections of the social–instructional environment. The conclusions and implications involve belonging as observed through lecture attendance, interpersonal dynamics in partner work, teaching practices of undergraduate instructors, the design of lab assignments, and the diverse demographics and preparation of the course's student body. We emphasize the rich nature of the ethnographic observations and the ways that they can index multiple social–instructional issues at work within one student-based vignette. In this way, interventions can be chosen to affect multiple learning challenges within a course.

#### 5.1.1. Implication 1: Group Learning Activities, Without Skill Training, Are Not Sufficient for Establishing and Sustaining Connections Among Students or for Supporting Their Sense of Belonging, Particularly for Underrepresented Students (Findings 1, 2, 3, and 4)

Based on best practices for retention and inclusion, this large, gateway course integrally incorporated collaborative learning opportunities for students in pairs and small groups: as active learning exercises in nearly every lecture and as the organizational premise of weekly lab sections. Yet in the focus group, interviews, and observations, students indicated that they did not feel sufficiently included or supported, putting them at risk of DFW status. One student in the focus group commented, "I feel like I'll be way behind my [lab] partner who started the lab, like a few hours before they came into the lab, you know, it's kind of hard to work with them if, you know, there's no flexibility or variability accounted for there" (Focus group, 24 March 2022). Students in this position may have relinquished agency in learning, worked independently despite group assignments, or abandoned the course altogether.

Students may feel better supported and, indeed, be better prepared to take advantage of collaborative learning activities, with reflective exercises and other activities that foster empathy and belonging. Mary Murphy (2024) found that mindset triggers—evaluative situations, high-effort situations, critical feedback, and the success of others—can lead to a fixed or growth mindset depending on how one is coached to navigate these triggers. A "culture of growth" both at an individual and course level can foster better performance, motivation, and behavior. For example, team-building activities followed by reflection exercises can help students understand the strengths and weaknesses of their own contributions to a learning team as well as appreciate the knowledge and constructive behaviors that others bring. Case studies of diverse or unlikely teams that pulled together for success can support this activity. Likewise, post-collaboration questions that invite reflection on roles and contributions can support social awareness. Such questions include, "Who wrote out the problem set today?" "Who got to speak?" and "At what point were different people's ideas incorporated into the problem today?" Answers could be held within groups or shared with the whole class as a way to support a growth culture. A discussion could foster empathy and solidarity among students, while the systematic as well as anonymous collection of this information can advise the professor about the possible need for intervention.

In addition, studies indicate that seeing that instructors and other course authorities reflect diverse identities contributes to learners' sense of belonging (Brooms, 2020; Hurtado & Ruiz Alvarado, 2015). Having diverse demographic representation across professors, graduate student instructors (when present), and UTAs can broaden students' sense of who belongs and who can succeed. By extension, UTAs, in particular, being more closely identified with the enrolled students, can embody role models and exemplars of success, which may foster better retention. To highlight this asset, perhaps hidden, each UTA might post a short profile of their achievements or a narrative of how they came to assist in the course.

Study spaces and mentoring opportunities can also be designated to welcome high-priority or at-risk student communities, such as those based on gender, ethnicity, or preferred language. For example, one lab or study group could be designated female-led to facilitate inclusion and excellence for those who prefer that setting. Other groups could be periodically led by program alumni or visiting specialists.

Group learning in computer science is meant to mimic workplace collaboration, but it does not allow for students to socialize or the social connections necessary for teamwork. Meanwhile, students felt the lab assignments took too long to complete, requiring time both in and outside of the lab, and many completed their work individually. Revising tasks so that they focus solely on partner work while also accounting for socialization (informal

team-building communication) may make assignments more manageable within a lab period. Moreover, designing lab exercises that require partner work may better leverage the social components of learning to code. With labs reserved exclusively for "partner time", homework can become more individualized, thus going "with the grain" of how students work and learn, including fostering allied skills of communication, common cause, and mutual respect. Resulting interpersonal bonds, our research and others' show, can help retain students in the course (Kelly et al., 2024).

#### 5.1.2. Implication 2: Whole-Class Meetings (Lecture Periods) Remain a Crucial Site for Concept Development, Belonging, Continuity, and Class Culture and, Thus, Need Navigational Markers Pointing to Their Centrality in Student Success (Findings 1, 2, 3, 4, 5, and 6)

To foster equity and belonging through group learning, students should be accountable for their learning and meaningful contributions to group learning. Students might view the group learning session as an alternative to the lecture session and, thus, attend the group sessions without developing essential knowledge on the content. Disparities in content knowledge among the students in group-learning environments could lead to ineffective learning experiences and even to inequitable contributions to group learning and decreased sense of belonging among the students.

While group-oriented labs may seem the more action-oriented place for students to work on understanding course concepts, whole class sections set aside for lectures often teach important course concepts and provide important navigational tools. Yet, students may feel more anonymous in these large-class settings, especially when faculty members simplify logistics by not taking attendance or giving credit for this fundamental work of learning. In addition, group and other active learning during lectures may undermine learning when attendance is inconsistent. Several students mentioned in interviews that in-lecture partner work and other instructional activities were adversely affected by a lack of attendance, both by students who missed a lecture or lab altogether and by those who had only inconsistent partners for learning activities. Having to establish credibility repeatedly with a rotating cast of attending students can be disheartening, especially for students of color or others who may be faced with a greater credibility deficit.

Moreover, instructors should explicitly describe the different purposes of lectures and group learning as distinct yet mutually reinforcing learning opportunities. For instance, group learning opportunities can be addressed as opportunities for students to develop different skills, such as professional collaboration and real-world application skills, while improving their confidence in communicating their content knowledge. On the other hand, lectures can act as a central navigational tool from which students learn about content, course structure, supplemental resources, course and career cultures, etc. Students who do not attend lectures or who are not oriented to the full course design will not fully understand how to navigate the course. For example, students who did not attend lectures regularly did not understand, even by week 11, the central process the course relied on. Incentivized navigational cues—such as providing points for attending lectures, rewarding completed activities during lectures, or removing universal access to recorded lectures—can point students to the centrality of lecture days in their success. Moreover, having all students together in one room can provide shared experiences and points of inclusivity, as well as connecting minoritized students or marginalized study groups to the whole. Additional resources, such as an index of online course structures, materials, and resources, would also guide students asynchronously.

#### 5.1.3. Implication 3: Complex Course Designs Must Be Organized in Ways That Affirm Students' "Rightful Presence", Which Requires Clear, User-Friendly, and Navigable Course Structures That Not Only Ensure Equitable Access to Resources but Also Remove Barriers That Render Students' Presence Conditional or Invisible Instead of Agential (Findings 4 and 5)

While the case study course was quite complex in instructional design, seeking to provide comprehensive and multimodal resources delivered via widely cited best teaching practices, it is not out of step with other large lecture, multi-section courses. The course studied implemented two levels of instructors (professor and UTAs): three endorsed websites (the university learning platform, the course-specific "legacy" website designed by the instructional team, and the Discord discussion) and four authorized meeting formats (required lecture, required labs, optional in-person or online office hours, and optional study sessions). Additionally, lecture sessions were recorded and website hyperlinks led to other topic-specific sites. Indeed, the phenomenon of computer programming "lock-in", in which many programs are built on and dependent upon a core program such that it becomes essential and difficult to revise or replace (Lanier, 2010, p. 7), can also apply to course programming. The accretion of learning fixes to a course over time can create an underlying structure that limits fresh, streamlined redesign. Complex and ambitious courses maintained over time may be especially susceptible to becoming bogged down with options and add-ons.

Although few students in our focus group expressed concern with finding online course materials, such complexity may be an overlooked area of confusion, especially for first-year and nonmajor students. A student in the focus group suggested that the course would be improved by having a "centrally located place where templates and data types can be found instead of searching for examples". Others in the focus group agreed that such a change would help them finish their class assignments in a more timely manner. Indeed, our ethnographer struggled with navigating both official university websites and external discussion sites, such as Discord. Students in our focus group did reference complexities, such as being unable to explain the Design Recipe coding guide, a key process for solving a problem in the course. Their lack of understanding of the logic behind the Design Recipe was apparent in explanations such as, "sometimes they just put the template together and run the code and it works". They further pointed to complex course structures to explain that they "saw" Design Recipe on the Legacy website but did not fully comprehend the importance of it until later lessons—perhaps too late to serve them well. In fact, our focus group students suggested making the course better by having a "centrally located place where templates and data types can be found instead of searching for examples". Other students concurred that such a change in guidance would help them finish their assignments in a timelier manner. In addition, we observed at least one student in the lab loudly commenting that he did not realize UTAs held office hours or were available for extra help. A comprehensive course navigation guide, such as a short video, power point presentation, FAQ list, or other index, could help students access necessary resources for learning. Likewise, lecture periods are natural times to announce office hours or point to relevant resources.

While it was not the focus of the study, we observed that consistent attendance at both lectures and group sessions (labs) is integral for students to meaningfully contribute to the group learning. Missing lectures prevented students from developing an understanding of core concepts and consequently from playing contributive roles in the group learning sessions. Research indicates that not just presenting and interacting in a group but rather collaborative contribution to group learning is appreciated among Black students (Priddie, 2021) and potentially among other underrepresented students. Lecture and group

learning sessions are not duplicative for skill development or professionalization and should not be used as alternatives to each other.

Put more directly, when students are not burdened with deciphering complex, ad hoc, and/or uncurated course structures, they can focus their time and energy on learning, contributing meaningfully with peers and claiming their place in the learning community. Clear, accessible design affirms students' rightful presence by recognizing them as full members of the learning community, equipped to engage, collaborate, and resist marginalizing dynamics (Calabrese Barton & Tan, 2020). Without such design, courses risk endorsing a deficit and exclusionary perspective—implicit in cumulative, opaque course structures—that blames students for failing to navigate a system never intentionally designed with them in mind. For students historically excluded from higher education, removing these barriers is not just supportive: it is affirming, and it cultivates a genuine sense of belonging.

#### 5.1.4. Implication 4: UTAs Who Succeed in a Course or Field Are Not Necessarily Prepared to Teach Equitably Without Additional Training (Findings 1, 3, and 4)

In general, UTAs bring little to no formal training in teaching to their work as peer instructors and would benefit from centralized training in high-impact instructional practices. Indeed, although they are not present in this case, graduate student teaching assistants will also be unevenly trained, in our experience. Ethnographer Seymour noted inconsistencies in how labs were led, possibly leading to different learning outcomes for the different sections. For example, some UTAs wait for students to ask for help, while others more proactively conduct a discussion about the day's topic. Similarly, some UTAs wait at the front of the room to be approached with questions, while others walk among students to invite questions. Some require students to work together, while others do not. Some allow students to leave before their partners finish, while others do not. These inconsistencies may favor certain, more assertive student groups above others as well as underscore or undermine the professor's preferred pedagogy on collaboration, resulting in uneven learning opportunities across sections.

Crucially, some UTAs will be better prepared to intervene in unequitable or uncomfortable learning situations than others. Not all UTAs will even recognize microaggressions or the signs of an underpowered student withdrawing from the learning process. In our observations, not every UTA addresses failing groups, so further guidance on knowing what to look for and how to help would be beneficial for bringing all intellects on task.

A pre-semester training unit, in addition to addressing teaching problems on a weekly basis, can prepare graduate instructors (when utilized) and UTAs with best practices for effective and equitable learning and teaching. Best practices for facilitating groups and partners, problem solving interpersonal dynamics, equitably sharing time and knowledge, and supporting underpowered members of the lecture or lab will benefit all students by supporting a more just, learning-centered environment. The training might include reflection on one's own blind spots, signs of a foundering collaboration, and well-founded ways to engage participants in active learning.

Techniques from Augusto Boal's (1985) *Theatre of the Oppressed* can be adapted to prepare instructors for problems when they arise. Generally, the *Theatre of the Oppressed* approach presents a challenging social situation that implicates matters of oppression, society, and activism. As a tool for education, it can be useful for bringing challenging social–instructional situations to life so that "audience" members can scrutinize and strategize better ways to proceed. For example, any one of the vignettes in this chapter's findings section would make a good start for understanding what went wrong and how an instructor might intervene productively.

### 5.2. Post-Observation Outcomes: Design Interventions

At the end of its study semester, the ethnographic team (Robinson and Seymour) compiled a "practitioner's report" for the course professor that provided vignettes, including those above, along with the implications of these observations for teaching and learning and other comments. We dialogued with the professor of record about rapid, high-impact changes that he could initiate immediately for the upcoming Spring 2023 semester.

For the shorter term, based on this input, the professor said that he

- provided greater transparency about goals and tools for success to students (knowing that success "just takes some practice" and course tools "definitely work").
- presented content theories and methods earlier and revisited them throughout the semester (understanding what is "really important, especially like when it comes to, like, the further lessons").
- implemented new training for UTAs based on the vignettes in a *Theatre of the Oppressed* approach (identifying and intervening so more students share the "gaming controller").

For longer-term impact, the professor said he planned to restructure lab work to achieve the following:

- promote more collaboration among lab and lecture groups ("share the work").
- implement activities to foster belonging in both the course and the computer science major (knowing "what to do" and where to access "help" so that students know, "you got this!").

Finally, in an effort to reinforce a key course concept, we observed that the professor now prominently wears a T-shirt he had printed that illustrates his design recipe coding process for computer science problem solving.

### 5.3. Post-Observation Outcomes: DFW Rates

Although we cannot claim a direct causal relationship to a complex qualitative environment, we discussed high-impact changes, noted above, that the professor incorporated into the course ecosystem. That ecosystem may be reflected in the student DFW rates in both overall rates and rates by gender and race. For overall recorded DFW rates, according to the university's office of institutional analytics, the recorded DFW rates were 39% prior to the observation semester and 60% during the observation semester. After the observation semester and intervention discussion had begun—that is, as the professor was making changes—the DFW rate dropped to 30% (of 132 students). The following semester, after the professor had fully incorporated the shorter-term recommendations, the DFW rate dropped to 24%, the lowest of all semesters for which institutional data are readily available, going back to Spring 2014. In fact, the average DFW percentage in this course from Spring semester 2014 to Spring semester 2023 is 42%. More specifically, the withdrawal rate for women (females) dropped from 39% in Fall 2021 to 14% post-intervention, with grades of A rising from 50% to 64%. Freshman and sophomore DFW rates fell in the same period from 40% to 26%. DFW rates of those repeating the course fell from 37% to 23%. African American and Hispanic/Latino students numbered too few to measure meaningfully. Meanwhile, enrollment demographics remained roughly consistent across the relevant semesters, though with a small number of females and racial and ethnic minorities enrolled during the semester we observed than in others (e.g., 12 vs. 17 females or 22% vs. 29% of total students, and similar variance for racial and ethnic minorities). Overall, the improved DFW measures may indicate the course is now less opaque, excluding, and byzantine to students, or as they put it, it may function less as "a weed-out" course and, instead, be more "worth going to", as a course in which the game controller is more in their hands.

### 5.4. Situating This Study and Directions for Future Inquiry

Earlier in this chapter, we argued that quantitative data, modeling, and analysis are insufficient to tell the entire story of what happens in instructional arenas. If that is true for quantitative methods, then it follows that it must also be true for qualitative approaches, such as those we took up for this study. No single conceptual, theoretical, epistemological, or methodological approach will reach a single truth of what may prevent student success in gateway courses with high DFW rates. Rather, we humbly suggest that ethnography is a powerful tool for studying higher education classrooms, offering valuable insights that can inform strategic decisions both at the course level and across the institution, in conjunction with other complementary approaches or as a standalone investigation of a particular phenomenon of interest.

Because this study was exploratory, it was necessarily circumscribed by issues related to course and participant access; researcher capacities, experiences, and dispositions; funding; time; and scope. For example, we limited the study to one computer science course in one semester, observed by one researcher. Moreover, any interventions based on these findings will be limited by available resources, including time, funding, personnel, and space. However, these constraints exist with any inquiry project or institutional research endeavor, highlighting the need for the epistemological and methodological diversity and evidentiary rationality described above. We suggest, then, that investigation into students' classroom experiences, their sense of belonging, and factors contributing to high DFW rates should be multimodal, multidisciplinary, and longitudinal, drawing on various methods, perspectives, and time frames to critically engage with the realities of teaching and learning in higher education.

Furthermore, given our focus on improving the DFW rates of minority students in the gateway courses, we paid more attention to group learning situations where minoritized students were present. In such situations, gender or race inequities were observed at least once in nearly every course meeting. However, as an exploratory study, we did not include the diverse ways in which people experience themselves as minoritized in our observations. We used race and gender as a proxy, an inroad, or a lens for a host of social complexities embedded in group learning circumstances. In other words, this study offers grounds and potential for future ethnographic studies on learning experiences of students with minoritized identities that are not necessarily visible (e.g., first-generation status, sexual orientation, nationality, etc.).

To that end, this exploratory study should be considered the first phase of a staged implementation of ethnography into classroom data collection that may supplement quantitative learning analytics. Each stage gathers incremental information about both the study methodology and the social–instructional environment for learning. Phase 1 focused on a single course as proof of concept. Phase 2 will compare the original course with a high DFW, multi-section course in Math. Phase 3 introduces the original single-course intervention as a foundation for more extensive research in eight multi-section, high DFW courses in computer science, chemistry, math, and business. Finally, Phase 4 focuses on faculty perspectives on the methodology and the recommendations it yields, including inquiring into their experiences of and strategies for belonging as they moved from their start in student learning groups to their present in faculty peer groups, especially for faculty of color and others who may be faced with a greater credibility deficit.

## 6. Conclusions

In this article, we are suggesting that a large public university's robust data infrastructure, tasked with informing educational improvement, can be usefully supplemented by ethnographic methods that center the student experience. Ethnography offers an important

lens for understanding the social environment of instructional settings, that is, how human beings respond to learning opportunities in the company of other people. Ethnographers enter as outsiders, expecting and respecting the logic of participants. For students, ethnography can "make the strange familiar" and for faculty, it can "make the familiar strange", as the famous saying goes. By making context-specific observations and claims, it can articulate between micro- and macro-phenomena, facilitating a multi-level analysis in ways that leverage how students encounter a course. Ethnographic approaches can supplement statistical data and learning analytics by re-centering the student experience with its nuances and day-to-day realities of marginalization, while feedback for instructors and others can energize change initiatives. Initial outcomes indicate the potential of ethnography to improve students' sense of belonging and contribute to improved DFW rates, particularly for minoritized and historically marginalized students.

Our findings suggest that faculty members should conceptualize their courses and classrooms as open systems, rather than closed. If instructional venues were closed systems, then faculty could tightly control variables leading to student success. However, anyone with any teaching experience would tell you teaching and learning are not hermetically closed; they are porous at best, as students and instructors come into courses with a range of skills, knowledge, and dispositions that existed before they ever walked through the classroom door. A more realistic and educationally responsive view of learning spaces would acknowledge them as open systems constituted by social, cultural, institutional, and political structures that exist both outside and inside classrooms. Without acknowledging and responding to this critical reality, faculty run the risk of alienating students, frustrating their sense of belonging, and ultimately reinforcing unnecessary barriers to their success. Our experience in this line of inquiry suggests that many faculty do embrace such a perspective, adding many socially responsive structures, such as labs and group work, to their courses, and they are eager to strategically identify and reform those instructional strategies that do not live up to their expectations.

Our study indicates promising directions for future inquiry and reform that can impact much larger numbers of students in courses across the higher education curriculum. It is clear that even knowledgeable and well-intentioned faculty members deploying widely recommended best practices can find themselves sponsoring courses in which DFW rates are considered too high and too inequitably distributed. Rather than doubling down on practices that may not be effective, faculty and researchers should pursue a greater understanding of the student experience through ethnography and other inquiry methods. In this way, we can respond to the needs of students from diverse backgrounds and academic preparation to approach the social–instructional setting with confidence that they belong and can access resources for better understanding course materials. Ethnographic observations identify important shortfalls and point to potentially transformative implementations for the redesign and preparation of group learning activities, strategic integration of lecture and lab sessions, addition of course navigation aids, and targeted pedagogical training for teaching assistants. We argue, finally, that the ethnographic approach offers tools that support better learning for the complex demography of today's college students. Overall, this study should encourage those who find that their efforts to implement novel and best practices fall flat. There is more to the social–instructional dynamic than meets the eye, and ethnographic observation can help access missing information that can create a better learning experience for all.

**Author Contributions:** Conceptualization, J.M.R. and R.S.; methodology, J.M.R. and R.S.; validation, J.M.R., R.S., S.J. and R.S.W.; formal Analysis, J.M.R., R.S., S.J. and R.S.W.; investigation, J.M.R. and R.S.; resources, J.M.R. and R.S.W.; data curation, R.S.; writing—original draft preparation, J.M.R. and R.S; writing—review & editing, J.M.R., R.S., S.J. and R.S.W.; supervision, J.M.R. and R.S.W.; project

administration, J.M.R.; funding acquisition, J.M.R. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by a grant from the Lilly Foundation to Indiana University.

**Institutional Review Board Statement:** The study was conducted in accordance with Indiana University Institutional Review Board protocol # 13901 (Approval Date: 19 January 2022).

**Informed Consent Statement:** Subjects' consent followed Indiana University Institutional Review Board protocol # 13901.

**Data Availability Statement:** Additional data is unavailable due to consent restrictions protecting the privacy of students.

**Acknowledgments:** We would like to acknowledge the Lilly Foundation's *Charting the Future* grant to Indiana University, which supported the investigation of undergraduate education and this project. Additionally, we also wish to thank Ken Shan, Logan Paul, Jill Robinson, and George Rehrey for their early discussions with Jennifer Meta Robinson about potential insights, limitations, and institutional interventions related to learning analytics studies, supported by funding from the American Association of Universities. Vic Borden and Becky Torstrick were invaluable collaborators throughout. Additionally, we appreciate the contributions of the *Education Sciences* staff and, especially, the anonymous reviewers whose excellent feedback enhanced this article.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

Agar, M. (1980). *The professional stranger: An informal introduction to ethnography*. Academic Press.

Alexander, C., Chen, E., & Grumbach, K. (2009). How leaky is the health career pipeline? Minority student achievement in college gateway courses. *Academic Medicine*, *84*(6), 797–802. [CrossRef] [PubMed]

Ali, L., Hatala, M., Gašević, D., & Jovanović, J. (2012). A qualitative evaluation of evolution of a learning analytics tool. *Computers & Education*, *58*(1), 470–489. [CrossRef]

Baepler, P., & Murdoch, C. J. (2010). Academic analytics and data mining in higher education. *International Journal for the Scholarship of Teaching and Learning*, *4*(2), 17. [CrossRef]

Bauman, R. (1983). *Let your words be few: Symbolism of speaking and silence among seventeenth-century quakers*. Cambridge University Press.

Bernard, H. R. (2011). *Research methods in anthropology: Qualitative and quantitative approaches* (5th ed.). AltaMira Press.

Blum, S. D. (2016). *"I love learning; I hate school" An anthropology of college*. Cornell University Press. [CrossRef]

Boal, A. (1985). *Theatre of the oppressed*. Theatre Communications Group.

Boas, F. (1887). *The social organization and the secret societies of the Kwakiutl Indians*. Government Printing Office.

Bourdieu, P. (1970). The Berber house or the world reversed. *Social Science Information*, *9*(2), 151–170. [CrossRef]

Brooms, D. R. (2020). Helping us think about ourselves: Black males' sense of belonging through connections and relationships with faculty in college. *International Journal of Qualitative Studies in Education*, *33*(9), 921–938. [CrossRef]

Buerck, J. P., & Mudigonda, S. P. (2014). A resource-constrained approach to implementing analytics in an institution of higher education: An experience report. *Journal of Learning Analytics*, *1*(1), 129–139. [CrossRef]

Caceffo, R., Gama, G., & Azevedo, R. (2018, February 21–24). *Exploring active learning approaches to computer science classes*. The 49th ACM Technical Symposium on Computer Science Education, Baltimore, MA, USA. [CrossRef]

Calabrese Barton, A., & Tan, E. (2020). Beyond equity as inclusion: A framework of "rightful presence" for guiding justice-oriented studies in teaching a learning. *Educational Researcher*, *6*(49), 433–440. [CrossRef]

Carspecken, P. F. (2005). The social relevance of critical ethnography. *Counterpoints*, *275*, 11–28. Available online: https://www.jstor.org/stable/42978774 (accessed on 19 April 2025).

Clandinin, D. J., & Connelly, F. M. (2000). *Narrative inquiry: Experience and story in qualitative research*. Jossey-Bass.

Cohen, E. G. (1994). Restructuring the classroom: Conditions for productive small groups. *Review of Educational Research*, *64*(1), 1–35. [CrossRef]

Cohen, E. G., Lotan, R. A., Scarloss, B. A., & Arellano, A. R. (1999). Complex instruction: Equity in cooperative learning classrooms. *Theory Into Practice*, *38*(2), 80–86. [CrossRef]

Constantinou, C., & Wijnen-Meijer, M. (2022). Student evaluations of teaching and the development of a comprehensive measure of teaching effectiveness for medical schools. *BMC Medical Education*, *22*(1), 113. [CrossRef]

Davidson, N., Major, C. H., & Michaelsen, L. K. (2014). Small-group learning in higher education-cooperative, collaborative, problem-based, and team-based learning: An introduction by the guest editors. *Journal on Excellence in College Teaching*, *25*(3&4), 1–6.

Davis, B., & Saunders, D. (2022). Critical quantitative research: Foreclosing criticality within education. *Critical Education*, *13*(2), 45–54. [CrossRef]

Delamont, S. (Ed.). (2012). *Handbook of qualitative research in education*. Edward Elgar.

Dennis, B. (2013). "Validity crisis" in qualitative research: Still? A movement toward a unified approach. In B. Dennis, L. Carspecken, & P. F. Carspecken (Eds.), *Qualitative research: A reader in philosophy, core concepts, and practice* (pp. 3–37). Peter Lang Publishing.

Desouza, K. C., & Smith, K. L. (2014). Big data for social innovation. *Stanford Social Innovation Review*, *12*(3), 38–43.

Dunbar, R. L., Dingel, M. J., & Prat-Resina, X. (2014). Connecting analytics and curriculum design: Process and outcomes of building a tool to browse data relevant to course designers. *Journal of Learning Analytics*, *1*(3), 223–243. [CrossRef]

Ely, M., Vinz, R., Downing, M., & Anzul, M. (1997). *On writing qualitative research: Living by words*. Falmer Press.

Eriksen, T. H. (1995). *Small places, large issues: An introduction to social and cultural anthropology*. PLUTO press.

Ferguson, R. (2012). Learning analytics: Drivers, developments and challenges. *International Journal of Technology Enhanced Learning*, *4*(5–6), 304–317. [CrossRef]

Foley, D. E. (1990). *Learning capitalist culture: Deep in the heart of Tejas*. University of Pennsylvania Press.

Fong, M. M., Huang, S., Alawini, A., Silva, M., & Herman, G. L. (2024, March 20–23). *Exploring computing students' sense of belonging before and after a collaborative learning course*. The 55th ACM Technical Symposium on Computer Science Education V. 1, Portland, OR, USA.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410–8415. Available online: https://www.pnas.org/doi/pdf/10.1073/pnas.1319030111 (accessed on 22 April 2025). [CrossRef]

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice*. Teachers College Press.

Geertz, C. (1998). Deep hanging out. *The New York Review of Books*, *45*(16), 69–72.

Gillborn, D. (2010). The colour of numbers: Surveys, statistics and deficit-thinking about race and class. *Journal of Education Policy*, *25*(2), 253–276. [CrossRef]

Hatfield, N., Brown, N., & Topaz, C. M. (2022). Do introductory courses disproportionately drive minoritized students out of STEM pathways? *PNAS Nexus*, *1*(4), 167. [CrossRef]

Hausmann, L. R. M., Schoffield, J. W., & Woods, R. L. (2007). Sense of belonging as a predictor of intentions to persist among African American and white first-year college students. *Research in Higher Education*, *48*(7), 803–839. [CrossRef]

Hinton, A. O., Termini, C. M., Spencer, E. C., Rutaganira, F. U., Chery, D., Roby, R., Vue, Z., Pack, A. D., Brady, L. J., Garza-Lopez, E., Marshall, A. G., Lewis, S. C., Shuler, H. D., Taylor, B. L., McReynolds, M. R., & Palavicino-Maggio, C. B. (2020). Patching the leaks: Revitalizing and reimagining the STEM pipeline. *Cell*, *183*(3), 568–575. Available online: https://www.cell.com/cell/fulltext/S0092-8674(20)31226-5?fbclid=IwAR0LUWQdrUjLb-YAbcsuPKG5zw1Hx9stozuotSiB7jhbjFt2ZoT0mXuVtcQ (accessed on 19 April 2025). [CrossRef]

Hooks, B. (1994). *Teaching to transgress: Education as the practice of freedom*. Routledge.

Howard, T. C. (2003). Culturally relevant pedagogy: Ingredients for critical teacher reflection. *Theory into Practice*, *42*(3), 195–202. [CrossRef]

Hurtado, S., & Ruiz Alvarado, A. (2015). *Discrimination and bias, underrepresentation, and sense of belonging on campus*. Higher Education Research Institute. Available online: http://hdl.handle.net/10919/83064 (accessed on 22 April 2025).

Iloh, C., & Tierney, W. (2014). Using ethnography to understand twenty-first century college life. *Human Affairs*, *24*(1), 20–39. [CrossRef]

Jakobson, R. (1960). Closing statement: Linguistics and poetics. In T. Sebeok (Ed.), *Style in language* (pp. 350–377). MIT Press.

Janke, S., Messerer, L. A. S., Merkle, B., & Rudert, S. C. (2024). Why do minority students feel they don't fit in? Migration background and parental education differentially predict social ostracism and belongingness. *Group Processes & Intergroup Relations*, *27*(2), 278–299. [CrossRef]

Jin, S., Rhee, B. S., & Jeon, S. (2020). Does "women friendliness" matter in STEM education?: Differential effects of high-impact practices on career aspiration of STEM college students by gender. *Journal of Engineering Education Research*, *23*(4), 37–51. [CrossRef]

Johnson, D. W., & Johnson, R. (1989). *Cooperation and competition: Theory and research*. Interaction Book Company.

Jones, R. W. (2007). Learning and teaching in small groups: Characteristics, benefits, problems and approaches. *Anaesthesia and Intensive Care*, *35*(4), 587–592. [CrossRef]

Kelly, M. L., Nieuwoudt, J., Willis, R., & Lee, M. F. (2024). Belonging, enjoyment, motivation, and retention: University students' sense of belonging before and during the COVID-19 pandemic. *Journal of College Student Retention*, 1–20. [CrossRef]

Kennedy, B. L., Habraken, M., & Melfor, S. N. (2023). Assaults on belonging: How Dutch youth without 'blue eyes, cheese, and clogs' experience everyday racism in educational contexts. *Race Ethnicity and Education*, *26*(5), 642–662. [CrossRef]

Kinzie, J., Thomas, A. D., Palmer, M. M., Umbach, P. D., & Kuh, G. D. (2007). Women students at coeducational and women's colleges: How do their experiences compare? *Journal of College Student Development*, *48*(2), 145–165. [CrossRef]

Kirner, K., & Mills, J. (2020). *Introduction to ethnographic research: A guide for anthropology*. Sage.
Koch, A. K. (2017). It's about the gateway courses: Defining and contextualizing the issue. *New Directions for Higher Education*, *2017*(180), 11–17. [CrossRef]
Koch, A. K., & Rodier, R. (2014). *Gateways to completion guidebook*. John N. Gardner Institute for Excellence in Undergraduate Education.
Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, *32*(3), 465–491. [CrossRef]
Lanier, J. (2010). *You are not a gadget*. Vintage.
Malcom, S., & Feder, M. (Eds.). (2016). *Barriers and opportunities for 2-year and 4-year STEM degrees: Systemic change to support students' diverse pathways*. The National Academies Press.
Malinowski, B. (1915). The natives of mailu: Preliminary results of the robert mond research work in British new guinea. *Transactions and Proceedings of the Royal Society of South Australia*, *39*, 494–732.
Malinowski, B. (1923). The problem of meaning in primitive languages. In C. K. Ogden, & I. A. Armstrong Richards (Eds.), *The meaning of meaning* (pp. 296–336). Harcourt, Brace & World.
Master, A., Cheryan, S., & Meltzoff, A. N. (2016). Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in computer science. *Journal of Educational Psychology*, *108*(3), 424. [CrossRef]
Matz, R. L., Koester, B. P., Fiorini, S., Grom, G., Shepard, L., Stangor, C. G., Weiner, B., & McKay, T. A. (2017). Patterns of gendered performance differences in large Introductory Courses at Five Research Universities. *AERA Open*, *3*(4), 1–12. [CrossRef]
McConnell, J. J. (1996, June 2–6). *Active learning and its use in computer science*. The 1st Conference on Integrating Technology into Computer Science Education, Barcelona, Spain.
McGee, E., & Bentley, L. (2017). The equity ethic: Black and Latinx college students reengineering their STEM careers toward justice. *American Journal of Education*, *124*(1), 1–36. [CrossRef]
Mead, M. (1928). *Coming of age in Samoa: A psychological study of primitive youth for Western civilisation*. William Morrow and Company.
Mertova, P., & Webster, L. (2019). *Using narrative inquiry as a research method: An introduction to critical event narrative analysis in research, teaching and professional practice*. Routledge.
Michaelsen, L. K., Knight, A. B., & Fink, L. D. (Eds.). (2004). *Team-based learning: A transformative use of small groups in college teaching*. Routledge Taylor & Francis.
Miner, H. (1956). Body ritual among the Nacirema. *American Anthropologist*, *58*(3), 503–507. [CrossRef]
Moghaddam, A. (2007). Action research: A spiral inquiry for valid and useful knowledge. *Alberta Journal of Educational Research*, *53*(2), 228–239. [CrossRef]
Molenda, M. (2003). In search of the elusive ADDIE model. *Performance Improvement*, *42*(5), 34–37. [CrossRef]
Mooney, C., Antoniadi, A., Karvelas, I., Salmon, L., & Becker, B. A. (2020, June 15–19). *Exploring sense of belonging in computer science students*. The 2020 ACM Conference on Innovation and Technology in Computer Science Education, Trondheim, Norway.
Mooney, C., & Becker, B. A. (2020, September 3–4). *Sense of belonging: The intersectionality of self-identified minority status and gender in undergraduate computer science students*. United Kingdom & Ireland Computing Education Research Conference, Glasgow, UK. [CrossRef]
Moya, J., Flatland, R., Matthews, J. R., White, P., Hansen, S. R., & Egan, M. L. (2023, March 15–18). *"I can do that too" factors influencing a sense of belonging for females in computer science classrooms*. The 54th ACM Technical Symposium on Computer Science Education V. 1, Toronto, ON, Canada.
Murphy, M. C. (2024). *Cultures of growth: How the new science of mindset can transform individuals, teams, and organizations*. Simon and Schuster.
Norris, D., Baer, L., Leonard, J., Pugliese, L., & Lefrere, P. (2008). Action analytics: Measuring and improving performance that matters in higher education. *Educause Review*, *43*(1), 42.
Oblinger, D. G. (2012). Let's talk. . . Analytics. *Educause Review*, *47*(4), 10–13.
Ochoa, T. A., & Robinson, J. M. (2005). Revisiting group consensus: Collaborative learning dynamics during a problem-based learning activity in education. *Teacher Education and Special Education*, *28*(1), 10–20. [CrossRef]
Pirker, J., Riffnaller-Schiefer, M., & Gütl, C. (2014, June 23–25). *Motivational active learning: Engaging university students in computer science education*. The 2014 Conference on Innovation & Technology in Computer Science Education, Uppsala, Sweden.
Priddie, C. A. (2021). *A Pathway toward cultural relevance: A QuantCrit analysis of collaborative learning experiences for Black STEM students through an anti-Blackness lens* (Order No. 28648295) [Doctoral dissertation, Indiana University].
Richardson, J. T. (2005). Instruments for obtaining student feedback: A review of the literature. *Assessment & Evaluation in Higher Education*, *30*(4), 387–415. [CrossRef]
Riessman, C. K. (2008). *Narrative methods for the human sciences*. Sage.
Rosenberg, M., & McCullough, B. C. (1981). Mattering: Inferred significance and mental health among adolescents. *Research in Community & Mental Health*, *2*, 163–182.

Sax, L. J. (1994). Retaining tomorrow's scientists: Exploring the factors that keep male and female college students interested in science careers. *Journal of Women and Minorities in Science and Engineering*, *1*(1), 45–61. [CrossRef]

Schiffrin, D. (1986). *Discourse markers, studies in interactional sociolinguistics*. Cambridge University Press.

Seals, D. R., & Coppock, M. E. (2022). We, um, have, like, a problem: Excessive use of fillers in scientific speech. *Advances in Physiology Education*, *46*(4), 615–620. [CrossRef]

Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary Educational Psychology*, *21*(1), 43–69. [CrossRef]

Spalding, N. J., & Phillips, T. (2007). Exploring the use of vignettes: From validity to trustworthiness. *Qualitative Health Research*, *17*(7), 954–962. [CrossRef] [PubMed]

Spooren, P., Brockx, B., & Mortelmans, D. (2013). On the validity of student evaluation of teaching: The state of the art. *Review of Educational Research*, *83*(4), 598–642. [CrossRef]

Springer, L., Stanne, M. E., & Donovan, S. S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of Educational Research*, *69*(1), 21–51. [CrossRef]

Strayhorn, T. L. (2018). *College students' sense of belonging: A key to educational success for all students*. Routledge.

Svinicki, M. D., Williams, K., Rackley, K., Sanders, A. J., Pine, L., & Stewart, J. (2016). Factors associated with faculty use of student data for instructional improvement. *International Journal for the Scholarship of Teaching and Learning*, *10*(2), n2. [CrossRef]

Teranishi, R. T. (2007). Race, ethnicity, and higher education policy: The use of critical quantitative research. *New Directions for Institutional Research*, *2007*(133), 37–49. [CrossRef]

Theobald, E. J., Hill, M. J., Tran, E., Agrawal, S., Arroyo, E. N., Behling, S., Chambwe, N., Cintrón, D. L., Cooper, J. D., Dunster, G., Grummer, J. A., Hennessey, K., Hsiao, J., Iranon, N., Jones, L., Jordt, H., Keller, M., Lacey, M. E., Littlefield, C. E., . . . Freeman, S. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *Proceedings of the National Academy of Sciences*, *117*(12), 6476–6483. [CrossRef] [PubMed]

Willis, P. E. (1981). *Learning to labor: How working class kids get working class jobs*. Columbia University Press.

Wilson, S. B., & Varma-Nelson, P. (2016). Small groups, significant impact: A review of peer-led team learning research with implications for STEM education researchers and faculty. *Journal of Chemical Education*, *93*(10), 1686–1702. [CrossRef]

Wolcott, H. F. (1973). *The man in the principal's office: An ethnography*. Holt, Rinehart and Winston.

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education*, *8*(1), 69–91. [CrossRef]