

# Connecting the Dots: Intersectionality across Active Learning, Classroom Climate, and Introductory Computer Science Courses

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## Abstract

Computer Science (CS) majors and researchers play a pivotal role in shaping the future of society, both as influencers and contributors to technological advancements. However, the lack of diversity in the CS field continues to perpetuate existing systemic inequities in current and future technologies. Over the last decade, the concept of intersectionality has been adopted by the STEM education research sphere to better understand how systemic issues impact student classroom experiences and broadening participation efforts. In this paper, we specifically examine how the theory of intersectionality has been interpreted in CS education research, particularly in the context of active learning and introductory courses like CS1. This paper synthesizes literature from computer science education, the sociology of education, and intersectional studies to better understand existing gaps in research about the student experience in active learning introductory CS courses through an intersectional identity lens. Key takeaways are provided on how these topics have been connected in CS education literature, along with research opportunities that incorporate all three components, to enable CS education research to achieve a positive impact on students' ability to succeed in computer science while acknowledging their intersectional positionality.

## CCS Concepts

• **Social and professional topics** → **Computing education.**

## Keywords

Intersectionality, Identity, Active Learning, CS 1, Classroom Climate

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## 1 Introduction

Classrooms are a reflection of society [9] and similarly have various stakeholders with independent interests, goals, and privileges. Classrooms, or courses, have three main stakeholders: instructor, student, and space (i.e., institution, school, pedagogy, contextual discipline, and the culture associated with it) that intertwine to facilitate courses [31]. Social science researchers analyze how stakeholders interact with one another in different contexts at a broader level by considering, assuming, or limiting the attributes of one or more of the stakeholders, due to the complexity of tracking the myriad of variables involved as one broadens the scope of the study [46]. A social contract binds these stakeholders together in the form of syllabus, degree, performance reports or tests, etc. [3]. Therefore, to better understand the student experiences in any computer science course, it is crucial to observe and explore systemic level factors that influence how a course is designed and how students experience the course through patterns in their perception with an intersectional lens [2, 36, 43]. We need to understand student experiences in their nuanced contexts if we are to further the Science of Broadening Participation in Computing, a major thrust for a global society [44]. The curriculum and course structures have gone through an extensive redesign with more focus on fast adaptability and very little time or thought has been put into best practices for implementing/bringing in the change in student experience along with learning [4]. To our knowledge, research efforts to quantify specific course design and teaching practices in a way that allows for explicit examination of the relationship between variations in teaching practice and student experiences and success in these courses through the lens of identity are few [40, 42, 60]. We are embarking on a new era of potential to more fully understand the nuanced experiences of students from an identity-based approach, which will serve to enlighten our awareness of how identity connects with early learning experiences in CS. There are many notable reasons why investigating intersectional identities is important, all of which point to making computing more reflective of

a global society: equitable education access socio-economic mobility, catalyzing innovation, ethical development, and applications of technology [38].

The term intersectionality references the critical insight that race, class, gender, sexuality, ethnicity, nation, ability, and age operate not as unitary, mutually exclusive entities, but rather as reciprocally constructing phenomena [15]. Often, researchers focus on one demographic feature without fully grasping how these identities interact to create dynamic power imbalances [51, 58]. Hill-Collins (2015) emphasizes the need to examine intersectionality as a field of study situated within power relations, as an analytical strategy to provide new perspectives, and as a critical praxis informing social justice. The need for an intersectional approach in studying educational contexts stems from understanding how systemic inequalities are perpetuated through educational policies that play out in classroom environments [14, 67]. The inherent challenges of investigating classroom climate are compounded when considering intersectionality theory [39]. Research methodologies often perpetuate further systemic inequities by misrepresenting the student experience due to a lack of deeper reflection on how students' identities in society shape their classroom experiences [23]. This paper aims to explore the literature on intersectional identity and social theories at the crossroads of identity and education to enhance the implementation of intersectional identity studies in CS education research. We examine how intersectionality theory and its variations have been incorporated into CS education literature over the last decade and how it has informed and shaped the work currently underway. We identify what is known and unknown in existing research and highlight emerging directions for the future of intersectionality in CS education, particularly in the context of implementing active learning pedagogies in introductory CS courses.

## 2 Background

Despite efforts to address race and gender disparities in CS education, a comprehensive intersectional analysis remains lacking [32]. To understand the nuanced challenges faced by students in computer science, it is essential to explore previous social theories and frameworks that have been used in CS Education literature to highlight the interplay between identity and academic success. Weidman's theory of undergraduate socialization highlights interpersonal interaction as one of the key processes of socialization, which is crucial for navigating the field and achieving upward mobility through education and work [65]. This theory connects the role of peer and faculty relationships in a student's academic journey, particularly how these interactions can be influenced by parental approaches. Similarly, Science identity, which refers to one's personal connection to their field, becomes a part of their sense of self [11]. Understanding how racial and socioeconomic backgrounds influence these identities can shed light on barriers faced by underrepresented minorities in computer science [5, 24, 64]. Critical race theory and concepts of "science as White property," provide a framework for understanding the racial dynamics in STEM education [17, 55, 69] and emphasizes how race and racism structure inequality and power dynamics in education. For instance, the perception of STEM fields as White male domains can affect students'

sense of belonging and academic performance [26, 41, 45]. By examining these intersections, researchers can uncover the nuanced ways in which race and identity influence classroom climate and student experience. By applying an intersectional lens to research, a better understanding of the broader social factors affecting student success is possible. Research shows that when students experience a sense of belonging and support on campus and in the classroom, they are more likely to persist through academic challenges and earn their degrees [30]. According to Rainey, four key factors contribute to students' sense of belonging: interpersonal relationships, perceived competence, personal interest, and science identity [50]. For example, young men from racially stigmatized groups are often perceived as problematic, impacting their sense of belonging and academic performance [37]. Societal perceptions of race and gender can lead to toxic environments, particularly for male-identifying students who do not conform to hetero-normative masculine identities [48]. Student perceptions of teachers also hinder their pursuit of academic pathways supporting economic mobility. White men are often unaware of the impacts of race and gender, while women of color frequently report that these factors affect their STEM experiences [17]. Additionally, exploitative lending practices disproportionately affect underrepresented racial groups, exacerbating education financial burdens and dropout rates. An intersectional lens approach reveals how privilege and socio-economic capital shape educational experiences [7]. Analyzing how factors such as academic preparation, educational contexts, psychosocial processes, and financial capital intersect with identities can reduce barriers to CS education [8, 59]. Studies examining the intersections of race, gender, and social class with students' sense of belonging [22] suggest that mindset plays an important role in promoting student success; students who believe they can develop their abilities and cultivate their intelligence are said to have a growth mindset, which can positively shape their academic achievement.

### 2.1 Intersectional Lens for Active Learning and Introductory Course's Classroom Climate

Literature indicates that active learning with an emphasis on students' growth mindset, may have a measurable impact on students' self-efficacy compounding over time [63]. Student success in introductory CS courses (CS1 & CS2) is generally linked with prior coding experience [61], course design/teaching practices [13], and students' sense of belonging [33]. There is mounting evidence that active learning that incorporates a growth mindset atmosphere is beneficial for all students, and especially leads to significant gains for students from marginalized groups [63]. However, there are many different ways to employ active learning [53], and mixed results from the literature suggest that not all active learning interventions are equally effective.

**2.1.1 CS1.** In introductory CS courses, it is important to find significant factors impacting students' decisions to pursue and persist in CS majors. Identity plays a crucial role in these courses, as students navigate new environments and form their sense of belonging in the discipline [19]. Introductory CS courses, identified as crucial to success in the CS education pathway, have inadvertently functioned as "gatekeepers" that hinder student success in the CS major, affecting retention and contributing to the "leaky pipeline," especially for

women, non-binary, and racially marginalized students [10, 38, 57]. Research shows that students’ cultural and socioeconomic backgrounds significantly influence their interest and performance in introductory courses [12]. An intersectional approach can inform strategies to support diverse students and ensure that introductory courses are inclusive and equitable [27]. For instance, introductory courses are critical for shaping students’ perceptions of the field and their future success, how do race, gender, and class influence students’ perceptions of computer science and their academic self-efficacy?

Research indicates that active and collaborative learning strategies in CS1 can improve student outcomes and close equity gaps [35, 38, 63]. However, the diverse identities of students necessitate a closer examination of how these strategies are implemented and experienced. For example, the variation in active learning strategies across CS1 courses, such as flipped classrooms and lightweight teams, can have different impacts on students based on their identities [34, 66]. Understanding how factors like stereotype threat, impostor syndrome, and sense of belonging influence student experiences can inform more inclusive teaching practices. By applying an intersectional lens, researchers can better understand the complexities of student engagement and success in CS1 courses. Faculty are paying more attention to communication strategies and fostering a growth mindset to create inclusive success [16, 49, 54]. This includes examining how different curricula, tools, and guiding pedagogies impact diverse student groups [36]. By addressing these factors, researchers and educators can create transformative teaching environments that support the success of all students, particularly in introductory courses where identity plays a significant role in shaping academic experiences and outcomes [35, 56].

**2.1.2 Active learning.** Active Learning encompasses a range of teaching strategies that engage students as active participants in their learning during class time [6]. These strategies, such as journal writing, problem-solving, and structured team-based learning, have been shown to improve learning outcomes and student satisfaction [1]. Collaboration and social interaction are integral to active learning, where practices like pair programming, team assignments, and peer mentoring help to build community and enhance engagement [20, 34, 47, 70]. These elements can provide socio-academic integrative moments that foster a sense of belonging and improve student outcomes [18, 63]. As active learning becomes more prevalent, it raises questions about the impact of social dynamics on team formation and learning experiences. For example, the implications of teacher-selected versus student-formed teams from an identity perspective must be considered. The framework of “science as White property” can help explore the intersections of race, ethnicity, and gender in active learning environments [17, 69].

**2.1.3 Classroom Climate.** Shaped by interpersonal interactions and teaching practices, classroom climate plays a critical role in student engagement and success. Research has shown that inclusive classroom environments, which consider students’ diverse backgrounds, contribute to better learning outcomes [25, 68]. Active learning requires an appropriate learning environment to implement the strategies effectively [28]. For instance, flipped classrooms and increased structure can benefit first-generation college students by providing clear expectations and support [21, 29]. However, it’s

essential to consider how these practices affect students from various intersectional identities. For instance, do certain active learning strategies disproportionately benefit or disadvantage specific groups? How do students’ cultural backgrounds shape their experiences in a flipped classroom? Exploring these questions can help educators create more equitable and inclusive learning environments.

### 3 Research Methodology

In this section we outline the research methodology we followed to further understand active learning, classroom climate, and intersectionality in introductory computer science courses (CS1). A systematic literature review was conducted in the ACM SIGCSE Digital Library of papers published between 2010 and 2021 and was followed by a thematic Analysis of the resulting 519 papers [62] to further understand the research landscape related to these terms. This was done by the first author reading and identifying keywords and symbolic tags for each paper. After a round of doing this, the process is repeated but with a focus on identifying patterns and commonalities across the papers to categorize them into code groups [52]. The analysis phase involved repeated comparisons of emerging codes and pre-established labels. Selective coding techniques were used, with qualitative verification strategies employed to ensure consistency and accuracy in code application. This approach resulted in the development of thematic labels which help frame the research landscape.

Search Keywords	Number of Papers
CS1	1,401
Active Learning	642
Intersectionality	32
Classroom Climate	29
CS1 & Active Learning	230
CS1 & Classroom Climate	19
Intersectionality & CS1	9
Active Learning & Classroom Climate	6
Intersectionality & Active Learning	5
Intersectionality & Classroom Climate	1
CS1, Intersectionality & Active Learning	4
CS1, Active Learning & Classroom Climate	3
CS1, Intersectionality & Classroom Climate	0

**Table 1: Summary of number of papers for each keyword search results from ACM Digital Library SIGCSE Database**

#### 3.1 Systematic Review

The systematic review process was as follows: Search in the ACM SIGCSE database (which includes SIGCSE TS, ITiCSE, and ICER Conferences etc) for papers with the words CS1, intersectionality, active learning, and/or classroom climate in various combinations with a date range filter.

**Inclusion Criteria:** Each paper had at least two of the search words in the abstract, title, keywords, or full paper text, and was a journal or conference proceeding. **Exclusion Criteria:** The paper

was excluded if content was limited to only one keyword, i.e. it did not discuss at least two key word topics.

Posters were excluded due to their limited content. A curated corpus of 338 papers was selected for further analysis, focusing on 230 papers about “CS1 & Active Learning” to search for references to identity or intersectionality. An expanded search across all ACM publications for “intersectionality” returned 341 papers, these papers were also added to the corpus due to the scarcity of intersectional literature in areas combining CS1 and active learning. The refined corpus comprised 519 papers, after removing redundant papers from all the searches and removing papers that were not research-focused (see table 1).

## 4 Analysis Results

The number of papers returned for each keyword or combination of keywords search is shown in Table 1. The search results show substantial interest in foundational courses and pedagogical methods: 1,401 papers for “CS1” and 642 for “Active Learning”. In contrast, the terms “Intersectionality” and “Classroom Climate” have much lower studies and appearing in 32 and 29 papers respectively indicating less attention to these topics in general. Results from combinations of two and three keywords showed an even more pronounced gap: the papers about “CS1 & Active Learning” total 230 papers, while combinations involving “Intersectionality” resulted in much fewer papers, with no papers found for “CS1, Intersectionality & Classroom Climate.” Examining the venues for research related to these terms, Figure 2 shows that the SIGCSE Main Technical conference and ITICSE conference, followed by ICER, are the venues where most research on “CS1, Intersectionality (identity), and Active Learning” is discussed in the field of CS Education Research. Looking at the timeline of the 519 papers that resulted from our systematic review, Figure 2 shows a substantial increase in interest in these topics after 2016 (27 -> 74) and 2020 (73 -> 111). In 2016, active learning as a pedagogy began to gain more popularity as a research topic in the field of CS Education. This increase in attention can be attributed to the growing recognition of active learning’s effectiveness in improving student engagement and outcomes. The only break in the increase is 2020\*, which is an outlier year due to the global COVID-19 pandemic, which disrupted normal academic operations. However, it also spurred interest in remote learning and digital pedagogy, which may have long-term impacts on CS education research. The thematic analysis revealed the following themes in relation to “Identity”:

**Collaboration** “pair programming has been shown to be highly effective for computer science” “Collaborative engagement or sharing within students increases their mastery over the topic...” “Peer Instruction (PI) or Mentoring (PM) is a pedagogical technique to increase ...”

**Curriculum Change** “We introduced a new program to our degree” “departmental responses to dynamic external forces (e.g., booming enrollments, shifting realities related to COVID-19) impact diversity efforts” “designing computing curricula for increasingly diverse groups of students, especially as pertains to the emerging field of culturally responsive computing”

**Pedagogy-based intervention** “We introduced.... System to the classroom and that resulted in ....” “Introduced .... Pedagogy and

paired by student ability perform better than those...” “introduced .... to Group A, Group A performed better than group B in ....” “Working in teams improved .... students ability to succeed based on the pedagogy technique introduced”

**Classroom Climate** “attitudinal change towards computer science among students differently based on ....” “.... tool introduction impacted students by .... at the end of the semester” “effort to improve student performance in a .... Classroom” “lower student engagement, yielding poor learning”

**Student Experience** “Assessing and analyzing how the student’s motivation and learning process were affected” “characterize the root of student struggles from many perspectives, including cognitive, meta-cognitive, and social-emotional”

**Individual demographic approach** “Male vs Female students performance in CS course when .... was introduced” “gender-focused interventions intended to increase the number of women in the field of computing.”

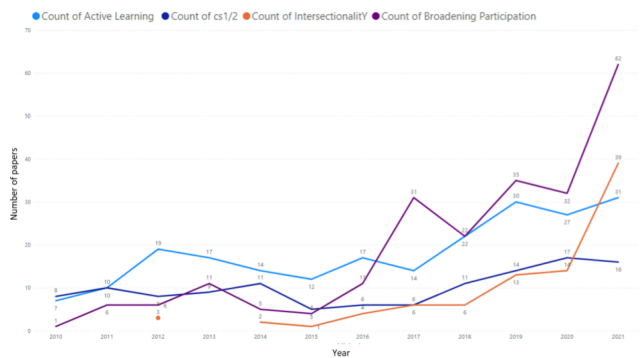
**Sense of belonging** “Computing self-efficacy and sense of belonging are known predictors of motivation and persistence” “Students’ sense of belonging has been found to be connected to student retention” “sense of belonging can show variations according to factors such as ethnicity and gender as well as influencing attributes such as motivation and persistence.”

**Broadening Participation** “Increasing retention in computer science (CS) courses” “connecting to larger community value systems as a context for doing computing.”

**Intersectionality** “Gender and race impacted ....” “Students of minoritized groups continue to disproportionately face challenges ....” “students who are historically underrepresented in computer science (CS), including women, Latino men, and Black men, as well as post-traditional (older or working) students” “These correlations were nuanced based on students’ gender, race, and the type of learning environment.” “experiences being Black women academics enduring a global pandemic that is disproportionately impacting” “Disability as an identity needs to be looked at along with race and gender to ....” “Women are underrepresented in CS but women of .... Or with .... Are even more ....”

The thematic analysis provided further insights into factors influencing active learning, classroom climate and student identity. Research on collaborative learning, curriculum changes and pedagogy-based intervention often focuses on implementing active learning strategies to enhance student learning experiences. Additionally, themes like broadening participation, individual demographic approach, and sense of belonging closely relate to student identity and encompass research aimed at creating inclusive learning environments in introductory computing courses.

Our emphasis on identity naturally extends to the theme of broadening participation which involves efforts to include diverse student populations in computing programs. We looked at the frequency of usage of the words active learning, CS, intersectionality (identity) and broadening participation over the past decade. Figure 1 shows the frequency of these terms. A trend can be observed for the increase in research about CS1 (2017) after the increase in active learning (2015). Despite being the anomalous period for growth in active learning and CS1 research, 2017 is also the year where research with the theme of broadening participation saw the greatest increase (11 -> 31) in terms of publications. It can be

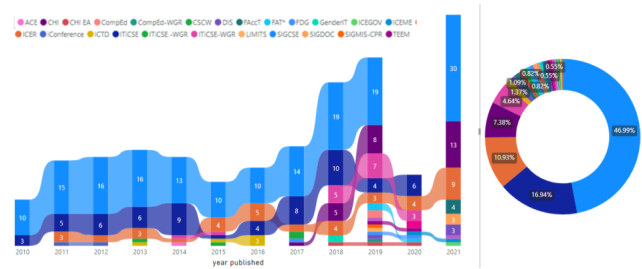


**Figure 1: The progression of papers that used the words Active learning, CS1, and Intersectionality and broadening participation between the years 2010-2021**

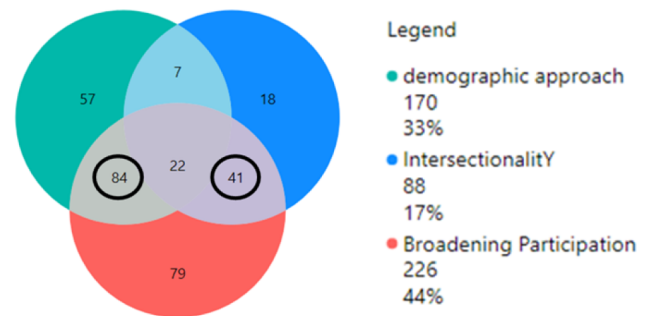
observed that both broadening participation and intersectionality have gained a lot of attention after 2020.

When it comes to how researchers approach understanding the impact of identity on student experience, comparing the number of papers that studied Identity as a part of their research with Fig 1 shows that despite an increase in papers on the topic of identity, the adoption of an intersectional approach or looking at multiple identities together w.r.t analysis in the CS field stays relatively small with papers under single digits till 2018. The lower adoption rate of intersectional approaches before 2018 could be due to the complexity of analyzing multiple overlapping identities and a lack of methodological tools to handle such analyses. As awareness of intersectionality grew, so did the development of frameworks and tools to study it, leading to increased research post-2018. Race and gender have been explored as factors that impact student experience but very few studies consider both together. Even fewer venture into the impact of socioeconomic status with race and gender on students' ability to succeed in CS which has been more broadly explored in the Sociology of education. The use of the word intersectionality has increased in frequency after the year 2020: from 14 to 39. The scope of our research specifically examined the generated thematic labels through their association or connection to the intersectionality theory or identity approach.

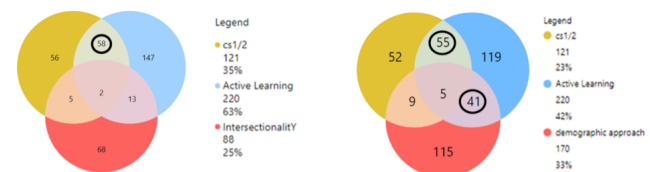
Fig 3 utilizes a Venn diagram to depict how research focused on identity is often driven by efforts to broaden participation in the CS field (41 out of 88 papers). The diagram, differentiated by color codes representing various research themes, shows that most papers on broadening participation predominantly adopt an individual demographic approach (84 papers), compared to an intersectional approach (41 papers). Within the broader research area, the trend continues with the individual demographic approach appearing more frequently (57 papers) than the intersectional approach (18 papers). Although some studies mention intersectionality, their analyses typically adhere to an additive approach to data, focusing on singular demographic factors. This contrasts with the core principle of intersectionality, which views identity as multiplicative and interwoven, rather than merely additive. Fig 4 is a second Venn diagram used to further examine which approaches have been utilized to study active learning through an identity lens in the context of



**Figure 2: The distribution of the papers across the conferences over the years within the ACM-SIGCSE Community**



**Figure 3: The distribution of papers across the labels in the theme Identity totaling 308 papers.**



**Figure 4: The distribution of papers at the intersection of the labels related to original search words totals 349 papers**

introductory computing courses. The figure shows that active learning is a predominant topic in CS1 with 58 papers and that when it comes to active learning research seems to take the demographic approach (41) more than the intersectional approach (13).

### 5 Discussion

This systematic literature review reveals a significant shortage of comprehensive studies meeting the inclusion criteria, notably within the SIGCSE database (see table 1).

**Underrepresented Intersectionality:** Research on active learning and introductory computer science courses (CS1) often lacks an intersectional perspective. Many studies focus on individual demographic factors like race, gender, or socioeconomic status without examining how these elements interact to shape student experiences and outcomes. There's a substantial research gap regarding how socioeconomic status, sexuality, disability, and other identities influence student success in the classroom.

**Importance of Classroom Climate:** Despite being crucial for student engagement and achievement, classroom climate is seldom explicitly studied in computer science education to understand students' cognitive experiences. Active learning methods significantly alter classroom dynamics, suggesting their potential as proxies for examining classroom climate. Faculty need effective and accessible strategies to create student-centered environments that foster adaptive learning.

**Pedagogical Interventions:** The analysis indicates that many papers propose classroom interventions and pedagogies as solutions to external inequalities affecting students. However, the complex nature of student identities and the external barriers they face underscore the need for more comprehensive studies that incorporate these factors. While various pedagogical approaches—such as project-based learning, peer instruction, and flipped classrooms—have been shown to improve student outcomes and engagement, additional research is necessary to understand their impact on diverse student demographics from an intersectional standpoint. Future research approaches should distinctly separate and address:

- **Studies employing an intersectional lens** to examine the nuanced interactions between various identities, pedagogical interventions, and classroom climate factors.
- **Intersectional data analysis methodologies** that move beyond additive approaches to capture the complexity of intersecting identities.
- **Demographic studies** that provide detailed insights into specific population group's experiences.
- **Research on intersectional populations** that considers the unique experiences and challenges of groups at the intersections of multiple identities.
- **Development of best practices and methods** for both qualitative and quantitative methodologies to effectively study intersectionality in CS education.

An intersectional lens is essential to understand the complexities of experiences for students at the intersection of underrepresented identities, such as female students of color, BIPOC from low socioeconomic backgrounds, non-traditional students, caregivers, rural students, and LGBTQ+ students. Finally, research should focus on data visualization methods and techniques to understand demographic information in education, particularly visualizing intersectionality. Identifying patterns in student demographics from an intersectional lens and finding effective ways to visualize this data can better inform who is underrepresented in computer science and how to address their unique challenges.

## 6 Conclusion and Future Work

Future research should examine how combined teaching practices (collaborative, active, and inclusive techniques) affect student experiences and how a sense of belonging, influenced by motivation, engagement, peer interaction, and communication, impacts success from an intersectional perspective in introductory CS courses. The contribution of this survey is in highlighting the gaps and connections between active learning, classroom climate, and intersectionality in CS education, which underscores the importance of adopting a more comprehensive approach to research and practice.

This approach can lead to a deeper understanding of the multifaceted nature of student identity and experiences while contributing to the development of more effective and inclusive educational strategies.

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