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Perspective

Who Gets to Belong in Chemistry? A Decolonization Perspective Informed by Dominant Group Theory

Zakiya S. Wilson-Kennedy [1,2,*], Raeshan D. Davis [3] and Christen D. Jones [1]

[1] Department of Chemistry, Louisiana State University, Baton Rouge, LA 70803, USA; cjon435@lsu.edu
[2] College of Science, Louisiana State University, Baton Rouge, LA 70803, USA
[3] College of Arts & Sciences, The Ohio State University, Columbus, OH 43210, USA; davis.7832@osu.edu
* Correspondence: zwilson@lsu.edu

Abstract

A sense of belonging in science, technology, engineering, and mathematics (STEM) education is often conceptualized primarily through social dimensions, overlooking its disciplinary and epistemological contexts. In chemistry, understanding belonging requires examining how disciplinary culture, values, and norms shape who feels included and who is excluded. This perspective article explores belonging in chemistry (a STEM discipline) as a multidimensional construct, emphasizing the intersections of social, cultural, and epistemic dimensions that influence students' participation and identity development in chemistry. Through a critical synthesis of literature informed by dominant group theory and decolonization frameworks, this work interrogates how Eurocentric definitions of merit and excellence perpetuate exclusionary practices and constrain the belonging of nondominant groups. The analysis identifies key opportunities in chemistry to support the participation of all and offers asset-based considerations for transforming departmental and instructional practices. We conclude that advancing belonging in chemistry requires reexamining disciplinary norms and adopting new approaches that validate multiple ways of knowing and contributing to the chemical sciences.

Keywords: belonging; dominant group theory; STEM education; reflection

1. Introduction

Belonging has significant implications for student success in higher education (Covarrubias, 2024; Li & Singh, 2023; Meehan & Howells, 2019; Ménard et al., 2024; Ravishankar et al., 2024). Scholars define belonging as "a fundamental human need and a basic right" (Strayhorn, 2018), encompassing an individual's perception of being welcomed, accepted, and included within a community or space (Covarrubias, 2024; Strayhorn, 2018). Covarrubias characterizes belonging as an intimate emotion bound by intersecting social influences that aim to encompass and exclude different social realities (Covarrubias, 2024). Strayhorn suggests that one's sense of belonging in educational spaces exists "where group members are significant to each other, and the group is affirmed, mirrored, and conveyed through a network of institutional policies, programs, and practices that clearly express that you are wanted, valued, and accepted within this space" (Strayhorn, 2018). It is shaped by various interconnected factors, e.g., individual identity, familial and societal heritage, interpersonal relationships, and the contextual impact of one's environment (Covarrubias, 2024; Freeman & Ortiz, 2019; Gopalan & Brady, 2020; Gravett & Ajjawi, 2022).

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Empirical research has sought to explain belonging and the ways in which perceptions of belonging influence persistence in educational contexts (Hansen et al., 2023; Kirby & Thomas, 2022; Li & Singh, 2023; A. L. Miller et al., 2019; Strayhorn, 2018). For instance, findings suggest that fostering a sense of belonging among students is crucial for their academic success and overall well-being within educational settings (Allen et al., 2024; Clements et al., 2022; Freeman & Ortiz, 2019; Hansen et al., 2023). Conversely, negative sociocultural cues can influence the academic success of students, including high academic achievers (Bayar & Karaduman, 2021; Good et al., 2012). As an example, studies have shown that despite strong academic performance, students from non-dominant groups in the U.S., experience disproportionate levels of attrition in science, technology, engineering, and mathematics (STEM) disciplines (Harris, 2019; Hays, 2008; Song et al., 2020; Thiry et al., 2019). This attrition occurs even when controlling for academic preparedness, suggesting that sociocultural cues, such as belonging, involve more than academic competence alone (Harris, 2019; Hays, 2008; Song et al., 2020; Thiry et al., 2019).

Moreover, studies have demonstrated that culturally relevant engagement and targeted support programs and initiatives can enable students to persist by helping them to see themselves as valued members of the academic and scientific community (Yabang et al., 2025). For example, Indigenous students in biomedical sciences and related fields were more likely to persist based on access to support structures that positively impact belonging factors. Herein, critical financial support, targeted fellowships, and scholarship programs provide dedicated safe spaces, mentoring, and a grounded acknowledgement of Indigenous ways of knowing that help to build confidence and spark career aspirations and intentions (Yabang et al., 2025). Broader findings suggest that culturally responsive educational programs positively influence Indigenous students' science identity and engagement by validating their cultural background and ways of knowing (Jin, 2021).

The implications for chemistry are clear. Fostering a sense of belonging in chemistry, through affirmation of identity, cultural relevance, and mentoring, can be a critical lever in advancing the participation and success of all students in our discipline. Belonging is especially important in chemistry because high-impact learning environments provide the conditions for all learners to engage, persist, and thrive, regardless of background (Graulich et al., 2023). These findings underscore the significant importance and impact of belonging in chemistry education on student engagement, academic success, and overall sense of validation within the scholarly community.

Dominant Group Culture Impacts Belonging and Merit for Non-Dominant Groups

The current discourse on belonging in higher education often focuses on social integration within the college environment (Freeman & Ortiz, 2019; Ménard et al., 2024; Strayhorn, 2018; Tellhed et al., 2017). While important, this focus on the social foundations of belonging overlooks the unique contexts that shape chemistry training and culture. In STEM learning environments, especially within the U.S., belonging is not solely about social connections but is deeply influenced by perceptions of merit, scientific knowledge, performance, and recognition (Belanger et al., 2020; Carlone & Johnson, 2007; Kim & Sinatra, 2018; Kim et al., 2018). This focus on academic competence and validation of that competence creates additional dimensions of complexity for students, especially for potentially vulnerable populations who may feel marginalized despite demonstrating academic ability (Allen, 2025). Herein, the concept of dominant group culture can help to explicate this phenomenon (Adejumo, 2021).

Dominant group culture significantly shapes the merit-based ideologies that influence belonging by defining what is considered legitimate knowledge, valid accomplishments, and valued intellectual contributions (Adejumo, 2021; Carter & Welner, 2013; Delpit, 2006;

Patel, 2015; Yosso, 2005). By privileging their language, education, institutions, social standards, etc., dominant groups set implicit and explicit cultural norms and systems that are often biased toward the majority identities (Apple & Apple, 2004; Bourdieu, 1991; Delpit, 2006; Yosso, 2005). This has the potential to negatively affect non-dominant groups by failing to validate their knowledge and sending subtle sociocultural cues that suggest they do not belong.

The dominant group culture is inherently connected to colonization because colonial power structures historically elevated their dominant groups, while erasing or marginalizing non-dominant groups, identities, and cultures (Quijano, 2000; Tuhiwai Smith, 2012), whether intentionally or non-intentionally. We note that dominant group membership may be generalized by a number of identifying factors, including gender, economic class (affluent/low-income), geographic location (rural, urban, suburban), race and ethnicity, ableness (disabled, able-bodied, neurodivergent), and others. Dominant group theory posits that dominance is not simply a result of having a demographic majority but about controlling a 'community's resources, norms, and institutions by shaping laws, policies, education, media, and cultural values (Razzante & Orbe, 2018). Herein, dominant groups frequently expect non-dominant groups to assimilate and suppress their own cultural expressions or identity markers, which often reinforces inequities (Hooks, 2014; Tatum, 2017). Given that dominant group culture establishes implicit and explicit criteria for defining "merit" and that there is significant evidence that belonging intersects deeply with notions of merit and academic validation, addressing the critical impacts of dominant culture on chemistry learning environments necessitates an approach that deeply acknowledges dominant group culture and its resulting consequences for non-dominant groups.

Our perspective article features an analysis that explores how decolonizing belonging, or more specifically, acknowledging the impacts of dominant culture on non-dominant groups, can support efforts to broaden the participation of all in chemistry. The purpose of this analysis is to illuminate how systemic structures, societal norms, and dominant group ideologies shape students' experiences of belonging in chemistry, particularly by identifying and understanding the factors that either foster or hinder a sense of belonging among non-dominant groups and potentially vulnerable populations. We will examine the = systematic structures that influence belonging in chemistry, considering how they intersect with issues of dominant/non-dominant group dynamics of power, privilege, and exclusion. Emerging from this analysis, we offer practical recommendations for creating high-quality learning environments that support all students, particularly those from non-dominant groups. This analysis is positioned as a starting point to challenge the current status quo in chemistry education, acknowledging that decolonizing belonging is a multifaceted and systemic challenge that requires the sustained, collective efforts from educators, policymakers, and academic institutions to transform chemistry environments into spaces where all students belong, experiencing both validation and support. Notably, faculty have the opportunity to foster belonging in their classrooms and spheres of influence.

2. Decolonizing Belonging: Insights from Dominant Group Theory

Decolonization refers to the process of overcoming dominant group culture by challenging and dismantling structures, epistemologies, and practices that have historically shaped and controlled academic spaces (Gjøvik, 2025). It involves rethinking the Western-centric frameworks of knowledge production and integrating "othered"" (Kumashiro, 2000; Shahjahan et al., 2022), often marginalized, perspectives, cultures, and methodologies (Gichuru, 2024; O'Neill et al., 2023). This process could include revising curricula to incorporate Indigenous knowledge systems, promoting more inclusive research agendas, and fostering equitable representation within the academy (Gichuru, 2024). Decolonization

also requires addressing systemic inequalities within academic institutions, ensuring that all have greater access, support, and opportunity (Gjøvik, 2025; O'Neill et al., 2023; Stein & Andreotti, 2016). By challenging the legacies of colonial dominant group influence on scientific practices, decolonization aims to create a more utopian environment wherein all voices are heard and valued, and opportunity gaps are alleviated (Cicek et al., 2023; de Sousa Santos et al., 2016; Stein & Andreotti, 2016).

This focus on decolonization becomes especially important when considering the significance of belonging in chemistry higher education. In recent years, efforts to increase participation in chemistry for all have gained momentum (Burke et al., 2022; Dasgupta & Stout, 2014; National Center for Science and Engineering Statistics [NCSES], 2023; Wilson-Kennedy et al., 2020, 2022) and necessitated a deeper understanding of how our systems impact all populations. Traditional dogmas in chemistry often tie belonging to scientific competence and performance, suggesting that individuals who excel in their field are more likely to feel a sense of belonging. However, despite demonstrating proficiency, non-dominant groups are more likely to experience a lack of recognition and validation, resulting in a diminished sense of belonging (Brockman, 2021; Good et al., 2012; Tellhed et al., 2017). Applying dominant group theory as a critical lens, the relationship between merit and belonging can be materializes through systemic barriers, which create environments that are not welcoming of non-dominant groups in chemistry (Dortch & Patel, 2017; Jackson, 2016; Ménard et al., 2024; Ovink et al., 2024; Rodriguez & Blaney, 2021; Taylor & Turk, 2019; Williams et al., 2014).

To broaden participation in chemistry for non-dominant groups, it is essential to shift toward a new understanding and approach to fostering belonging (Shahjahan et al., 2022). In practice, decolonizing belonging would challenge and intentionally dismantle colonial dominant group structures and epistemologies, and intentionally integrate non-dominant, often marginalized perspectives (Gichuru, 2024; O'Neill et al., 2023).

3. Exploring Belonging in Chemistry as a Multidimensional Construct

Belonging in chemistry is deeply influenced by dominant cultural norms and merit-based ideologies (Gilani et al., 2024). Given that dominant groups define what is valued as scientific competence and performance, often marginalizing non-dominant groups (Bhopal, 2020; Kozlowski et al., 2022; McCabe, 2009; Morton & Nkrumah, 2021), if we seek to create learning environments that are welcoming for all, we must interrogate our mental models of belonging.

3.1. Belonging and Persistence

A comprehensive review of the literature on belonging reveals that scholars have collectively defined it as a deeply rooted sense of being genuinely valued, accepted, and recognized as an integral member of a group (Baumeister & Leary, 2017; Fong et al., 2024; Gopalan & Brady, 2020; Maslow, 1943; Strayhorn, 2018). One of the earlier frameworks, Tinto's Theory of Student Departure, has played a pivotal role in shaping our understanding of student integration and student persistence in learning spaces (Tinto, 1987, 1993). Building upon this concept, Hurtado and Carter further advanced the understanding of belonging in learning spaces, positing that community membership is essential for fostering a sense of belonging (Hurtado & Carter, 1997). Grounded in these foundational assumptions about belonging, the work of Strayhorn further contributes to our understanding of this complex and multifaceted concept of belonging. His model on College Students' Sense of Belonging illustrates the intricate relationship between fundamental human needs and the presence of nurturing and supportive environments as crucial components of an individual's sense of belonging (Strayhorn, 2018). Furthermore, this conceptual framework

underscores the multifaceted nature of belonging, illustrating how it can be influenced by a wide range of factors, including one's diverse identities, the social contexts in which they exist, and the specific circumstances that manifest within educational environments.

3.2. Belonging as Capital

An essential component of an individual's feeling of acceptance and inclusion within a particular social group or community is their ability to navigate the customs, values, and behaviors of that specific culture. Bourdieu theorized that an individual's participation and sense of belonging in social settings are primarily influenced by the possession of cultural capital (Bourdieu, 1986). Cultural capital encompasses various elements, including education and language, social connections and memberships, financial resources, and material possessions (Bourdieu, 1986; Tilbrook & Shifrer, 2022).

Bourdieu's theory suggests that powerful societal groups maintain their advantage by controlling access to different forms of capital, such as economic, social, and cultural resources. While Bourdieu's theory of cultural capital has been widely used to analyze differences between sub-populations, it is important to recognize that this perspective may unfairly exclude certain groups because they lack traditional forms of capital (Kingston, 2001; Lamont & Lareau, 1988; Sullivan, 2002; Yosso, 2005). This approach often views these groups from a deficit standpoint and fails to acknowledge the value and significance of the capital that non-dominant groups possess, thus perpetuating a cycle of inequality and disadvantage that results in marginalization. Social capital and belonging are intricately tied, and intergroup dynamics play an important role in understanding this phenomenon.

3.3. Belonging and Science Identity

To deepen the understanding of belonging in chemistry, the Science Identity model provides a valuable framework, highlighting three interconnected factors (i.e., competence, performance, and recognition) influencing an individual's sense of belonging in science spaces. Competence refers to an individual's understanding of chemistry content matter (Carlone & Johnson, 2007). Performance entails the active demonstration and application of scientific knowledge and expertise; more specifically, it is defined by an individual's ability to use chemistry knowledge (competence) in diverse settings, including laboratory, classroom, and other professional spaces (Carlone & Johnson, 2007). Recognition is the acknowledgment and validation of an individual's competence and performance within the chemistry community (Carlone & Johnson, 2007; Sandrone, 2022). These factors interact dynamically, each influencing the others in shaping an 'individual's science identity development. Within this model, the assumption is that as individuals demonstrate their competence in chemistry content, perform their disciplinary knowledge, and receive recognition through merit for their competence and performance, their science/chemistry identity is strengthened, ultimately leading to an increased sense of belonging in the chemistry community.

3.4. Belonging and Dominant Group Theory

While science identity is framed as a neutral concept of belonging, the systems and practices shaping it within learning environments can be biased and exclusionary. Previous research on chemistry culture, contexts, and learning environments consistently shows that a sense of belonging is heavily influenced by the norms of the dominant societal groups in discipline culture (Bhopal, 2020; Kozlowski et al., 2022; McCabe, 2009; Morton & Nkrumah, 2021). Eurocentric perspectives and knowledge systems have significantly influenced the norms and culture within chemistry. Non-European (and non-Western) identities, scientific knowledge, and contributions are frequently disregarded, especially when deemed to be misaligned with the dominant culture (Allen et al., 2021; Philip & Azevedo, 2017). As

an example, a deliberate omission of scientific insights and practices from Indigenous cultures within the dominant Western scientific framework is a significant consequence of the dominance of Eurocentric ideologies (Philip & Azevedo, 2017; Pokhrel, 2011). Such exclusion perpetuates inequality in both the recognition and dissemination of knowledge, hindering the advancement of diverse identities and perspectives in scientific discourse.

Longstanding biases in academia continue to equate scientific excellence with Western institutions, thereby limiting the visibility and valuation of diverse contributions (Khalid & Ting, 2025). As an example, there are many instances when researchers from more privileged, high-income countries conduct studies in less privileged, lower-income regions without meaningful engagement or collaboration with local scholars (Adame, 2021; Asase et al., 2022; Odeny & Bosurgi, 2022; Roldan-Hernandez et al., 2020; Stefanoudis et al., 2021). These types of "helicopter research" and "parachute" scientific practices marginalize researchers from less privileged groups by excluding their epistemologies (Lambert et al., 2024; Stefanoudis et al., 2021), thereby reinforcing privileged and dominant group frameworks of knowledge production (Gjøvik, 2025). This structural imbalance not only undermines capacity-building in under-resourced regions but also perpetuates systemic inequities in authorship, recognition, and scientific legitimacy. These exclusionary practices are sustained by unequal power dynamics and institutional norms that systematically "other" non-Western scholars and communities (Fluit et al., 2024).

4. Who Belongs in Chemistry?

Learning environments often embrace merit-based structures as a means of stratifying individuals. The concept of merit refers to the idea that individuals are recognized and rewarded based on their qualities and actions (Blair-Loy & Cech, 2022). In chemistry, merit often plays a prominent role in shaping the experiences of individuals based on their ability to obtain recognition for their work (Blickenstaff, 2005; Duncan & Zeng, 2005). Merit encompasses various aspects, including but not limited to, increased financial support, access to highly sought-after professional opportunities, and inclusion within the broader scientific community (Blair-Loy & Cech, 2022; Roithmayr, 1998; Walker et al., 2010). Therefore, acquiring merit not only validates an individual's standing within their scientific community but also serves as a signal of belonging and acceptance. The question we ask is who determines the criteria for merit within our discipline, and do these criteria privilege some and disenfranchise others?

Previous scholarly research has extensively highlighted pervasive systemic inequities and biased environments in chemistry higher education, shedding light on the barriers that hinder the success and acknowledgment of individuals from non-dominant groups (Cheryan et al., 2017; Geesa et al., 2021; Reinholz et al., 2019; Sparks et al., 2021). The impact of such environments can potentially alienate even the most qualified individuals from non-dominant groups (Ito et al., 2025). Good and colleagues summarized that "when the sense of belonging is reduced, individuals may opt out of the domain—even when achievement remains high—to pursue studies and professional goals within a different discipline that better enables this sense of belonging to take root" (Good et al., 2012, p. 701). Simply, individuals may abandon their chemistry pursuits for other opportunities where they perceive they belong. Therefore, it is crucial that we explore and understand this phenomenon to create a more inclusive and equitable chemistry higher education.

Understanding the impact of these biases on students' sense of belonging is crucial. Several aspects contribute to the bias in the culture of chemistry. For instance, students from historically excluded groups, which are a type of non-dominant group, often find classroom spaces unwelcoming, competitive, and discriminatory toward students of color and women (Agrawal et al., 2016; Allen-Ramdial & Campbell, 2014; Castro, 2014; Davis &

Wilson-Kennedy, 2023; Fries-Britt et al., 2013; Ito et al., 2025). They often face the burden of proving their intellectual capabilities to faculty and peers, irrespective of their preparation and performance. These experiences can diminish a student's sense of belonging, even if they are academically talented and, in principle, should belong in that space. Belonging must be grounded in the fundamental components of science identity and the environment, and members of the chemistry community must recognize the value of an individual's abilities, as well as when they may be underrecognizing an individual's abilities.

Mitigating bias in merit within chemistry involves implementing transformative approaches to objectively evaluate and address biases in policies, practices, instructional methods, funding, etc. These approaches should be grounded in the principles of objective meritocracy, ensuring that individuals are evaluated based on their abilities and accomplishments, rather than on factors unrelated to their qualifications. This emphasis on unbiased evaluation reassures the scientific community of the system's fairness, instilling confidence in the merit-based approach.

5. The Way Forward—Answering the Call

Decolonizing belonging in chemistry involves recognizing and addressing the deep-seated structural and systemic barriers that non-dominant groups navigate to belong in chemistry higher education. Wilson-Kennedy (2023) emphasizes that the focus needs to be on understanding and improving science learning and professional environments to be welcoming for all. Accordingly, decolonizing belonging calls for a comprehensive re-evaluation and transformation of higher education spaces to ensure that opportunities for fostering a sense of belonging are centered on an individual's competence and performance and that individuals are impartially recognized for the value of these abilities. This necessitated broadening our mindsets around how we value knowledge, what knowledge we value, and how we recognize excellence.

We believe the greatest opportunity for decolonizing belonging is transforming chemistry learning experiences. Individual faculty often have autonomy in how they approach their teaching and the way that they design learning experiences in their classrooms. Accordingly, we focus on steps individual faculty can take to recognize and counteract the influence of dominant group culture in chemistry spaces. Our recommendations emphasize teaching practices that promote success and inclusion for all students. While these examples are not exhaustive, they offer a useful starting point for purposeful action.

Reflective Practice and Self-Awareness: Individual faculty may be intentional about examining the lens through which they design instruction. Herein, they may reflect on personal preferences and biases, implicit and explicit assumptions about what excellence looks like to them, and how cultural assets and privilege influence their interactions with students (and colleagues) and their pedagogical practices. They may use journaling, self-assessments, dialogue with students and colleagues, exploration of literature, and other feedback opportunities to enhance self-awareness and accountability. See Supplementary Materials for a sample of reflection prompts that faculty may use to enhance self-awareness and advance reflective practice.

Broaden Content: Challenge and de-center dominant norms and narratives in the course policies and curriculum (Raycroft & Flynn, 2020). Learning environments are a critical element in shaping the experiences of individuals engaging in chemistry. As such, this strategy is a critical step to encourage the promotion of more perspectives and address biases to support belonging for all students. Some practical examples are:

Integrating scientific contributions, approaches, histories, epistemologies, and practices from non-dominant and marginalized communities into chemistry courses to provide a more comprehensive education (Gaotlhobogwe, 2023; Glazebrook, 2021; Howard et al., 2024).

Resources can be leveraged to identify chemists from non-dominant groups (Brown, 2018; Rayner-Canham & Rayner-Canham, 2008; Society, 2021; Tamao, 2025).

Review all course policies, syllabi, assignments, and grading criteria thoroughly to identify and remove any potential biases or obstacles to learning that could unfairly disadvantage students from non-dominant groups. This includes but is not limited to considering any language, examples, or cultural references that may inadvertently marginalize certain groups of students. This may be approached by including content, readings, or other ways of knowing from non-Western and other non-dominant groups, incorporating case studies that explore the relevant context for the advancement of science, and other similar strategies (Herreid, 2007; National Center for Case Study Teaching in Science, 2025).

Engaging students in regionally relevant scientific issues can create a shared platform for exploring diverse perspectives and addressing issues that affect everyone (Behl et al., 2024; Johnson et al., 2020; Vance-Chalcraft & Jelks, 2023). This sense of community and shared responsibility fosters a feeling of connection and involvement among students, making the learning process more meaningful and engaging. For example, in Louisiana, U.S., a regional topic for discussion is how petrochemicals impact local air and water quality; this leverages chemistry concepts of hydrocarbon chemistry, toxicology, and environmental monitoring. In Kenya, topics on water purification could be explored using charcoal, Moringa seeds, or nanomaterials for clean water; chemistry concepts would focus on adsorption and filtration. In southern Asia, dye pollution from textile industries could be explored with a focus on chemical treatments and an analysis of effluents; chemistry concepts would focus on organic dyes, spectroscopy, and biodegradation. Together, these could provide regionally relevant topics for exploration in chemistry classrooms.

Validate Multiple Ways of Knowing: Utilize non-traditional and more contemporary learning approaches and practices to engage all groups of students. Understanding and valuing students' lived experiences in the learning process can be transformational in changing instructional practices to center belonging for all. When students see their own experiences reflected in the curriculum, they are likely to find the learning process more stimulating and the content more accessible, leading to a more thorough understanding and retention of knowledge and skills, and seeing themselves as valued members of the scientific community. Moreover, elevating student voice provides unique opportunities (Hurtado et al., 2009; Le et al., 2019; Yabang et al., 2025).

Universal Design for Learning (UDL): a learning theory that supports and accommodates the needs of all learners in the learning process by engaging them in a learning environment that presents information in a variety of ways (Rose, 2000). The UDL approach cultivates belonging by valuing different learning styles and needs and offering multiple ways of expressing knowledge and representing content (Heelan, 2015; Nelson, 2021), thereby illustrating a respect for epistemological difference. This approach provides guidance that may be leveraged to explicitly integrate non-dominant knowledge traditions, community-based practices, experiential learning, scientific storytelling, and other similar practices into instruction. Drawing on the UDL framework, learning activities and assessments can intentionally incorporate multiple means of representation, action, and expression, and engagement to ensure that all learners have meaningful opportunities to succeed (CAST, 2018; Reyes et al., 2022). In practice, this elevates valuing a range of outputs, such as tactile model construction, annotated molecular diagrams, interactive simulations, virtual laboratory reports, community-based projects, or collaborative problem-solving sessions, as valid evidence of learning in chemistry (Baumann & Melle, 2019; Holländer & Melle, 2023; Horna-Saldana & Canaleta, 2024; Miano et al., 2023; Reyes et al., 2022).

UDL may be implemented in both small and large enrollment courses using a variety of flexible approaches. One strategy for exploring representational and conceptual

knowledge could leverage a molecular geometry assessment in a small class to build and defend physical models, while students in a large enrollment course could demonstrate the same competency through digital drawing and/or drag-and-drop tasks in a learning management system (Padalkar & Hegarty, 2015; Ward et al., 2025). Both formats can provide meaningful ways to engage students in multiple models of action and expression. Moreover, both formats, when scored with consistent rubrics, can provide reliable and comparable measures of student performance (Logan & Mountain, 2018; McKnelly et al., 2021; Oliver-Hoyo, 2003). See Supplementary Materials for additional UDL examples.

Curriculum Redesign: Faculty can work collaboratively to systematically redesign curricula in ways that respectfully integrate diverse epistemologies and ways of knowing, elevating non-Western scholarship and non-dominant group perspectives. Leveraging attention to Indigenous knowledge systems, this process should be intentional in moving beyond token inclusion to authentic co-creation of content with communities and knowledge holders, ensuring cultural protocols, intellectual property rights, and community priorities are upheld (Ziebell et al., 2021; Zinyeka et al., 2016). Approaches such as "two-eyed seeing", which bring together Indigenous and Western scientific perspectives to find common ground and produce stronger, more holistic outcomes, can guide this integration (Bartlett et al., 2012; Hatcher et al., 2009).

Practical strategies might include curriculum audits that identify epistemic and cultural biases; co-developed modules in which Indigenous and scientific inquiry processes are taught side-by-side; and place-based learning activities that embed time, place, and relationality as core scientific variables (Kristian et al., 2023; Latip et al., 2024). International examples demonstrate viable pathways: in Australia, chemistry laboratory projects have been developed in partnership with First Nations communities, with clear guidelines on when curriculum content can be developed independently by faculty and when collaboration is required to respect cultural authority (Ziebell et al., 2021); in Canada, New Zealand, and parts of Africa, local and Indigenous knowledge has been harmonized with formal science curricula through community-based, cross-cultural capability frameworks (Latip et al., 2024).

Faculty learning communities (FLCs): Faculty dialogue groups or learning communities offer a powerful structure for curricula change and personal reflection (Bailey et al., 2022; Beach et al., 2012; Cox, 2001). These communities provide a low-stakes environment for faculty to explore challenges, share practices, and build self-awareness over time. Moreover, engaging in reflection collectively, especially with peers from similar disciplines, encourages accountability and provides support when navigating complex issues such as bias, privilege, or inequities in learning environments, all topics salient to dominant group culture. Ongoing faculty development, embedded into the FLCs, could feature evidence-based practices with demonstrated efficacy with non-dominant groups. Herein, a series of lunch-and-learn workshops, or chew-and-chat sessions, focusing on innovations in assessment practices, anti-colonial pedagogies, and reimagined grading practices could provide a framework for building partnerships and collaborative action. Using UDL as a framework, chemistry faculty could explore a number of relevant instructional and assessment strategies (Drumm et al., 2024; D. K. Miller & Lang, 2016; Scanlon et al., 2018; Wojdak et al., 2024). Specifications grading could also be explored (Bunnell et al., 2023; Katzman et al., 2021; Streifer et al., 2024).

Notably, instructors in gateway chemistry courses often face strong content-coverage constraints. The recommendations mentioned heretofore do not have to be 'extras' but as design choices that shape how existing core content is accessed, practiced, and assessed. For example, using a UDL framework, many strategies can be implemented through 'swap, not add' substitution by reimagining an existing active-learning task to include structured

collaboration norms and multiple options for demonstrating the same learning outcome, with an explicit focus on belonging. Moreover, a tiered implementation pathway (low-lift changes → one-unit pilots → course-level redesign) and department-level supports such as shared artifacts and course materials can provide a manageable approach to engaging these changes. Herein, FLCs can be invaluable to this work.

6. Conclusions

By adopting a decolonization perspective informed by dominant group theory, faculty can pursue a number of approaches that foster belonging for all groups. Examples of specific approaches could include: (a) integrating non-Western scientific contributions into the curricula, (b) employing Universal Design for Learning (UDL) to accommodate multiple models of engagement, expression, and representation, and (c) employing evidence-based practices tailored to help the most vulnerable groups, thereby supporting the success of all (Amisi et al., 2024; de Sousa Santos et al., 2016; McClanahan, 2018). Additionally, adopting policies that promote the visibility of a wide array of role models provides resources that address the specific needs of marginalized groups, promoting a sense of recognition and validation within the academic community. By fostering an environment where students feel a strong sense of belonging, educators have an opportunity to enhance student motivation, retention, and overall well-being, ultimately contributing to a more diverse and productive scientific environment. This emphasis on belonging in chemistry higher education reflects a broader recognition of the importance of multifaceted perspectives, voices, and experiences in the chemistry enterprise.

Decolonizing belonging in chemistry requires our continuous commitment to addressing historical imbalances, existing power structures, and injustices that have long distorted who belongs in our learning spaces. While not all faculty are going to be inspired by this perspective, faculty who are motivated to foster belonging have leveraged this work as an evidentiary base and a practical set of strategies that can be used to begin and/or expand their work. The research-grounded rationales and adaptable entry points provided in this perspective may enable early adopters to champion the work locally—building social proof, shared language, and departmental capacity for broader uptake.

Transforming the existing fabric of higher education will require this type of intentional action, but the resulting outcomes will be worthwhile in our goal of broadening participation in our discipline. If we individually transform our respective areas of influence, we will have a collective effort that creates welcoming and engaging learning environments that recognize the efforts of all individuals without bias. Our collective efforts have the potential to produce an academic and professional ecosystem where individuals from all backgrounds feel equally valued and empowered to contribute to the advancement of science.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/educsci16020238/s1, Table in S2: Samples of UDL-Aligned Chemistry Activities and Assessments.

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