frontiers | Frontiers in Education

TYPE Curriculum, Instruction, and Pedagogy
PUBLISHED 13 July 2023
DOI 10.3389/feduc.2023.1167879

OPEN ACCESS

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RECEIVED 16 February 2023
ACCEPTED 27 June 2023
PUBLISHED 13 July 2023

CITATION
Audette DS, Bennett S, Chan MC, Chapman D, Elmendorf H and Floyd J (2023) Building an inclusive community of learners by centering a strong culture of care in large lecture classes. *Front. Educ.* 8:1167879.
doi: 10.3389/feduc.2023.1167879

Building an inclusive community of learners by centering a strong culture of care in large lecture classes

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Foundational and early university STEM courses are usually taught as large lecture courses. For many students, especially students from marginalized identity groups, a large course can be an impersonal experience that leaves students with a low sense of belonging, negatively impacting academic performance and retention in the discipline. In this paper, we present specific interventions and practices—cultivated through years of intentional iteration by multiple faculty—to build a community of learners that care for one another in a large foundational Biology course. We define our "culture of care" as building and maintaining a class structure and climate that empowers students to form relationships that provide emotional support and meet affective needs. We believe this allows students to persist and succeed in the course, and helps to build an understanding of how course material will lead to achievement of their intrinsic academic and career goals. We believe these interventions and practices leverage the unique benefits of large class sizes, including the diversity of students present and the power of shared positive group experiences. In this paper, we describe key aspects of the current course, including (1) pedagogical choices that help students invest in their learning and focus on key scientific skills, (2) training faculty and undergraduate assistant members of the teaching team to build a community that cares, and (3) designing assignments that focus on well-being and teamwork. Throughout this paper, we hope to provide a template that can be adapted to different disciplines and institutions for designing large lecture courses that are inclusive, engaging, and emotionally supportive.

KEYWORDS

inclusive pedagogy, equity in STEM, biology, culture of care, lecture course, Team teaching, peer mentoring, student well-being

1. Introduction

For many students, large courses are impersonal experiences that leave them without a sense of belonging to the community or a sense of ownership of their education (Cuseo, 2007; Allais, 2014; Hubbard and Tallents, 2020). It is particularly problematic when these large courses are a student's first exposure to a discipline or when students belong to groups that are underrepresented in the discipline (Hausmann et al., 2007; Jantzer et al., 2021). Over the years, the teaching teams of Foundations in Biology I (F1) at Georgetown University have tried different strategies, interventions, and structures to combat potential alienation by fostering a *culture of care* among our students, which we define as both *care for themselves as students and ownership of their own learning*, as well as *a feeling of safety from being cared for in their journey to gain knowledge and skills*. We believe that both parts of this culture of care are important for a student's opportunity to succeed in a course and to gain a sense of belonging in the community. We also argue that having a large group of students in an introductory STEM course helps to foster this sense of care. A larger crowd brings more diversity and a more broadly shared experience. Also, enthusiasm can be contagious–an analogy of this is the positive collective emotions experienced at a live concert in a community of fans with a shared sense of identity.

In this paper, we describe three specific strategies in building a culture of care along the lines described above:

1. Structuring the curriculum and making pedagogical choices that promote a culture of care as a transparent goal for students.
2. Training members of the teaching team (including both faculty and near-peer undergraduate teaching team members) to help model and build a culture of care for students.
3. Intentionally interweaving the intellectual and personal dimensions of the scientific endeavor in assignments center student's well-being and to activate intrinsic motivation for success.

2. Pedagogical framework

The approach we describe below is supported by research on effective strategies and interventions for STEM courses, large lecture courses, near-peer mentoring, and student well-being.

2.1. The importance of an equitable learning environment in introductory STEM courses

Our pedagogical framework first aims to create an equitable learning environment. The current understanding of an equitable learning environment is one that provides inclusive learning access, support, sense of value and belonging, consistency in assessments, and recognition of different needs for all students (Graham et al., 2013; Penuel et al., 2016). Teaching methods that address these needs include scaffolding of learning, transparency about course plans and expectations, promotion of a growth mindset, and mixed assessment methods (Cotner and Ballen, 2017). Importantly, these pedagogical approaches have been shown to help reduce achievement gaps in underrepresented minority students (URMs; Haak et al., 2011; Tanner, 2013).

Most of the approaches in the reviewed research are designed to shift away from unidirectional lectures toward a more interactive learning environment (Armbruster et al., 2009; Freeman et al., 2014). Incorporation of these active learning techniques, such as *think-pair-share* or group work, allows students to learn from one another, breaks up the monotony of a lecture, and emphasizes a growth mindset (Tanner, 2013). Setting up a collective growth mindset needs to take place in all parts of the course structure and design, especially the syllabus of a course (Tanner, 2013). Students, especially students new to college or a discipline, should be shown that the course is not testing for prior knowledge, but for growth. Up front, it should be clear that the course is designed so that all students can succeed and that it might take a period of adjustment to be successful. Students should know that faculty understand the anxieties, fears and imposter syndrome students might feel. By acknowledging these apprehensions in the syllabus and through other elements of the course, we can address apprehensions and help students get past them. This has been shown to be effective at reducing the performance gap between white students and students who are Black or Latinx in introductory biology (Bauer et al., 2020).

We are interested in building and maintaining diverse communities (and not gatekeeping) in this gateway course. Maintaining the diversity of students in an introductory science course is crucial for the success of the field. Research has shown that increasing diversity increases the pace of discovery and advancement in the field (Chang et al., 2006; National Science Foundation, 2008; Hill et al., 2011). Diverse communities that practice inclusion have been shown to benefit all students (Whitla et al., 2003; Chang et al., 2006; Freeman and Huang, 2014; Hanauer et al., 2017; Dutton, 2018).

2.2. Effectiveness of peer-led team-based learning in improving the success of a diverse student body

Various studies, including reports from different government agencies, have emphasized that a crucial mechanism for improving persistence within STEM degree programs is supporting development of students' STEM identity. Current research defines science identity as encompassing both competence, performance, and recognition, as well as social and cultural identities (Carlone and Johnson, 2007; Eccles, 2009; Herrera et al., 2012). Carlone and Johnson (2007) argued that underrepresented groups, though they may feel competent in their STEM knowledge and ability to showcase their STEM skills, may not receive recognition from their peers and more importantly their STEM professors. This lack of acknowledgement can affect students' sense of belonging and persistence within STEM fields (McDonald et al., 2019). Hallmarks of programs that promote STEM identity and persistence identified by the Joint Working Group on Improving Underrepresented Minorities Persistence in Science, Technology, Engineering, and Mathematics include mentoring programs and support systems (Estrada et al., 2016; Estrada et al., 2019). These programs develop connections between students and STEM faculty, peers, and the discipline in general [President's Council of Advisors on Science and Technology (PCAST), 2012; Estrada et al., 2016; The National Academies of Sciences, Engineering, and Medicine, 2016; Sweeder et al., 2019]. Integration of students into STEM-related social and intellectual communities fosters a sense of self-efficacy, belonging, and science identity in students (Thiry et al., 2011; Light and Micari, 2013; Zaniewski and Reinholz, 2016; Sweeder et al., 2019). Peer mentorship programs have also been shown to promote a sense of belonging and discipline-based identity, with a pronounced positive impact on URMs (Allen et al., 1999; Batz et al., 2015; Zaniewski and Reinholz, 2016; Anfuso et al., 2022).

A key to building a community that cares is to create a formal structure and opportunities for peer-led team-based learning (PLTL). In PLTL, near-peer undergraduate educators lead problem-based learned sessions to build mastery of course material or to foster success in the teaching laboratory (Golde et al., 2006; Wilson and Varma-Nelson, 2016). Peer leaders are instructed to guide students in education through a social constructivist framework. This framework leverages social learning theory, where learners learn from role models, and constructivism, where learners build their own mental framework for understanding material (Bandura, 1977; Bodner, 1986; Wilson and Varma-Nelson, 2016; Winterton et al., 2020). In one example, biology and chemistry majors participating in Northwestern University's Gateway Science Program (GSP) showed increased grades and retention in the major (Swarat et al., 2004; Drane et al., 2005). Training is a crucial part of the program. GSP peer leaders attend a pedagogy course and are coached weekly by faculty for the courses they are supporting (Micari et al., 2005). Participants of the GSP reported both improvement in their understanding and knowledge and increased ability to lead students in content discussion (Micari et al., 2005). Peer leaders' conceptions of teaching became more student-centered over the course of the class and their teaching experience (Streitwieser and Light, 2010). PLTL has also been shown to support equitable learning and reduce the achievement gap in STEM for women and URMs, with positive outcomes expected for both learners and peer leaders (Drane et al., 2005, 2014; Gafney and Varma-Nelson, 2008; Wilson and Varma-Nelson, 2016; Stanich et al., 2018).

2.3. Effectiveness of team teaching depends on the model of team teaching

One way to promote community building is through team teaching. Team teaching leads to student exposure to different perspectives, an increase in care of individual students, and increased student participation and dialog (Anderson and Speck, 1998; Carpenter et al., 2007; Gladman, 2015; Murawski and Lochner, 2017; McDonald et al., 2021). Team teaching allows students multiple opportunities to develop connections with faculty members. There are different models for team teaching, such as the rotational (sequential) model where individual professors join the team to teach the part of the content in which they are most expertly trained (Helms et al., 2005). Although potentially easier on the faculty, it leads to a disjointed learning experience and discourages relationship building between professors and students (Baeten and Simons, 2016). We argue that a better model of team teaching is rooted in dividing the course's responsibilities by section, such as one professor in charge of the lecture and one professor in charge of the lab. This achieves a combinatorial approach between parallel teaching and teaming, where lab professors lead the same content (parallel teaching) and teaming (where each member of the team has a defined role but there is collaboration toward planning, delivery, and evaluation). Our experience is that this model expands well to new faculty and new near-peer mentors, and models equity and collaboration, which leads to increased learning and engagement among all faculty and students (Ferguson and Wilson, 2011). Through establishing a lead of the lecture portion of the course, students gain the majority of the content from one professor, but co-teaching remains potentially powerful in impacting successful learning (Schmulian and Coetzee, 2019; Dang et al., 2022; McKenzie et al., 2022). Students regard variations among co-instructors as advantageous, leading to increased student interest, motivation, and learning outcomes (Anderson and Speck, 1998); whereas the sequential model increases student's negative perceptions of the course (Baeten and Simons, 2016). By having a sole professor in charge of the lecture material, students experience consistency in the teaching and assessment style. Similarly, in the lab space, they experience one professor and have an easier time developing a relationship with that professor in the smaller lab community.

2.4. Finding meaning by centering a sense of well-being and a culture of caring

Another key aspect of our course is assignment design that not only teaches content or skills, but also connects to students' personal and professional goals. This setup helps students build a culture of care for their own learning. Various studies have shown that *work meaning*, or the extent to which one sees one's work as meaningful, strongly correlates with commitment, engagement, and positive affect (Steger, 2013). The independent research assignment we assign is part of the Engelhard Project at Georgetown University. The goal of the Engelhard Project is to integrate student well-being and mental health issues into academic context (Olson and Riley, 2009; Finley, 2016; Valtin et al., 2018). Normalizing discussion on well-being, and centering student's sense of their own well-being in the classroom and their lives is correlated with success, and persistence (Bowen, 2017). Our assignments are also meant to promote relationship building between students and between faculty and students. For example, the labs require students to construct their own experimental design and then critically analyze the results with each other and the teaching team. In addition, the teaching team to student ratio is kept low, which allows students to not only get to know members of the teaching team, but encourages impromptu conversations during labs. SAAs are trained and encouraged to participate in these conversations as part of their work. In the STEM disciplines, Winberg et al. (2018) have argued that students' well-being is dependent on faculty to not only focus on knowledge and skills, but also the building of these meaningful relationships.

3. Learning environment

3.1. The basic structure of the course

Georgetown University is a predominantly white institution (PWI) where 50% of students identify themselves as White, 13% Asian, 8% LatinX/Hispanic, 6% Black and 6% as belonging to 2 or more races [National Center for Science and Engineering Statistics (NCSES), 2023]. In 2020–2021, 12% of undergraduates were awarded Pell Grants.

Foundations in Biology 1 (F1) is a 5-credit course that includes a single large lecture, smaller recitations, and up to 12 small lab sections. In total, F1 enrolls ~300 students annually with the largest enrollment (~240 students) in the Fall semester. The teaching team changes from semester to semester. The course is required for most science majors and also enrolls pre-health students from across different majors.

Most of the students (63.6%) are first-year students, so this course serves as an introduction to college biology and science. Post-baccalaureate pre-health students comprise 6.1% of the students

(Fall 2020–Spring 2023). 51.6% of students identify as White, 19.3% Asian, 6.5% LatinX/Hispanic, 6.0% Black, and 7.1% identify as two or more races. A majority of the class identify as Female (70%). The Georgetown Scholarship Program provides programmatic support for first-generation and low-income college students, with 7.5% of F1 students in that program.

The teaching team for the course is comprised of faculty who lead the lectures, recitations, and labs, as well as a large group of undergraduate Student Academic Assistants (SAAs) who apply to be part of the teaching team. The size of the team changes each semester, but we try to maintain a ratio of faculty to students at ~1:50, and SAAs to students is ~1:5.

3.2. Curriculum and pedagogical choices is the scaffold on which a culture of care and intellectual growth can occur

Biology is oftentimes taught as a number of disconnected facts with a large degree of memorization. This disadvantages students with lower prior knowledge and does not activate intrinsic motivators. Like many introductory courses, there are no prerequisites to take this course, and therefore we have students who have diverse prior knowledge, degrees of confidence, and science learning expertise. The F1 course content builds from a small number of core chemistry and physics principles at the beginning of the semester and these principles are used to explain complex biological processes later in the semester (Supplementary material 4: Lecture Calendar; Supplementary material 1: Course Syllabus). There are frequent formative assessments to check if students have gained mastery and know how to build on the framework, and we provide additional help for struggling students. By transparently explaining this conceptual framework to students, and bringing attention in later content to earlier concepts, we help students to use metacognition in their learning and care about their individual academic journey.

Setting up a growth mindset culture requires work and reinforcement throughout the course. The syllabus includes inclusive, informal language that lays out this philosophy, including direct language like "We believe that ALL students can succeed in this course, AND it can take a period of adjustment to be successful." This is reinforced via frequent low-stakes assignments and assessments that increase in difficulty as the semester progresses. Conversations on growth occur after each assessment, not only with faculty but with undergraduate SAAs as well, who share their own journey in the course. All teaching team members are trained to acknowledge student anxieties. SAAs are purposely recruited and selected based on different experiences in F1, including those who have succeeded despite initial struggles, specifically so that they can share their experience and present different models of success. We share these experiences through discussions during their training, and we also discuss strategies for acknowledging anxieties and sharing the varied experiences with those who might be struggling. By acknowledging these apprehensions, we can help students get past them. As mentioned before, SAAs are also trained to inform faculty and activate the Georgetown Safety Net (Olson and Riley, 2009) when students are in greater distress.

The labs in this course emphasize science as a creative process in which discoveries are often partial and uncertain, which can be both inspiring and frustrating for many of our students irrespective of prior content knowledge (Example of lab in Supplementary material 2). This approach to introductory laboratory courses immediately focuses on teaching students to develop scientific problem-solving skills and to make evidence-based arguments. We are transparent with students that the laboratory is meant to be challenging, to help build persistence and critical thinking in a relatively low-stakes environment. Teaching staff (both faculty and SAAs) guide student's thinking but do not answer questions in declarative ways. They are trained to never be 'the voice of authority' that students use to confirm a hypothesis, which emphasizes that there are aspects of learning Biology that are new to every student. The close collaboration between lab partners toward a common, sometimes frustrating, goal allows students to quickly build collaborative relationships.

The laboratory is structured to support a skill-growth mindset as well. Significant class time is devoted to teaching writing skills, and students can do targeted rewrites. Students are encouraged to use metacognition in these lab assignments through writing "meta-reflections," reflecting on what they have learned about being a scientist or on the nature of science itself.

Faculty hold extensive office hours, and—recognizing the importance of near-peer mentoring in the learning process—we have established the Georgetown University Science Study Center (GUSS, pronounced "Goose") that operates 6 days a week under SAA leadership. Students can drop in to GUSS to work with classmates, listen to what others are struggling with, work on the assignments from the course, or ask content questions. About 14% of students report that they attend GUSS "regularly or often," with ~45% attending "sometimes." Of those who attend GUSS, most students (>80%) report that they find GUSS useful (data from student survey in Fall 2020 and Fall 2021). For students with low confidence in their ability or who are struggling with the material, additional support through review sessions and private, free tutoring is provided. We also work with other parts of the administration to provide targeted assistance for first-generation students.

3.3. Building and maintaining a caring learning community by training a teaching team to care

Our teaching team changes from year to year; with ~1–2 new faculty and ~50%–60% turnover of our large team of SAAs. The turnover rate of SAAs can be attributed to two key factors, SAA graduation and degree requirement constraints. Additionally, as F1 teaching faculty transition to new roles within and outside of the department or university there is a conscious effort to hire dynamic and diverse faculty to teach this course, with 1–2 new faculty being added to the team year to year. Therefore, the expectations and culture of care has to be re-trained in both returning and new teaching staff alike.

One of the keys to building a community of care in the large course is by expanding the teaching team beyond faculty by recruiting, training and empowering undergraduate SAAs to be a crucial part of our team. SAAs are recruited primarily based on an expressed desire to help others succeed in the course, and secondarily for mastery of content. The desire to care for other students has to come from SAAs.

Every new SAA in F1 takes a course focused on pedagogy and learning (BIOL 203: Seminar Inquiry in the Foundations of Biology; Supplementary material 5: BIOL203 Syllabus). Within this course, we work with SAAs to activate their intrinsic goals to help current students succeed. A deepening of content understanding is learned through practicing how to teach that material to others; SAAs role-play lab interactions to learn how to guide student thinking without giving answers and practice providing holistic writing feedback to help students improve. There are also weekly discussions about interactions between students and SAAs, and how SAAs can provide care to students in specific scenarios.

The limits of SAA's responsibilities is also made clear:

1. SAA's are first and foremost students and their responsibilities should not affect their studies or success in other courses (we care about their well-being and success as well). Therefore, faculty check-in throughout the semester to make sure SAAs are not overwhelmed. When they need it, faculty have helped decrease work-load for specific SAAs.
2. SAAs cannot be responsible for "fixing" problems that a student might be going through, the SAA responsibility is to inform faculty. Faculty will then work with students and other services in the university to provide students with help needed.
3. Though they help grade various assignments, SAAs are not responsible for the grades students get in a specific paper or assignment; all grades come from faculty. Therefore, they can focus on helping students improve, and not on justifying a particular grade.

Newly-hired teaching faculty join the teaching team of either F1 or our sister course Foundations II and there is growing consensus that new tenure-line faculty should also join the teaching team. New faculty get to work closely with SAAs and small groups of students in the labs, allowing them to build relationships with individual students beyond what one can typically do in a lecture. Our team teaching model also includes weekly teaching observations and mentored opportunities to develop new material and pedagogies for labs and recitations. There are weekly faculty team meetings where much of the meeting is focused on discussing individual students who might be struggling and interventions we can activate in the course and with other groups in the university that can help. The underlying philosophy we cultivate in new faculty is to care for a student's well-being first, then provide equitable opportunities for students to succeed in the course. This training and immersion in the teaching team allows new faculty members to be inculcated in the culture of care that is central to our success as a Department.

Professors have autonomy over their section of the course. In this model, there are clear roles within the team as each professor is in charge of one (or more) sections of the course, which has been shown to increase job satisfaction among teachers (Vangrieken et al., 2015). While material used in each of these aspects of the course is shared and discussed, each professor has a voice in making the material better. As such, changes are made in each iteration of the course depending on the particular members of the teaching team. This methodology strikes a balance between autonomy and support in any given semester to the team of faculty. Furthermore, the course continues to change, and different faculty bring their strengths into the course (Hanusch et al., 2009).

3.4. Creating assignments that interweave the intellectual and the personal dimensions of the scientific endeavor to build a culture of care

Assignments are designed to be relevant to students' goals and well-being, helping to build a culture of care. Here we will discuss two assignments in the course, the first multi-week lab project (the Enzyme Lab; Supplementary material 2: Enzyme Lab Instructions) and the independent research paper (Supplementary material 3: Engelhard Paper Instructions). In both the lab and the independent research paper, students are given a great deal of latitude to think for themselves, exercise their creativity, and fully own their ideas and their work. This intellectual freedom increases the intellectual rigor of the course because in removing some structure, we move not only the constraints but also some of the supports. In a lab environment where students design their own experiments or a research project where they join an on-going scientific conversation in the primary literature, we explicitly convey our belief in their scientific identities and capabilities. We see them as scientists, and the product of their work is something that we care about.

This sense of ownership can be daunting to students. Therefore, in both the lab and the research project, SAAs are assigned small "flocks" of ~6 students that they work with for the whole semester and get to know each student quite well. Both labs and the research project are designed to encourage conversation among students and between students and their SAAs. This high contact means that if students were to face a crisis, or require help for any reason, there is a good chance the F1 team can identify and quickly respond.

The research project is part of the Engelhard Project for Connecting Life and Learning; a university-wide project that seeks to integrate issues of student well-being into academic contexts (Olson and Riley, 2009; Finley, 2016; Valtin et al., 2018). Within F1, students are instructed to research and write a paper about the interplay between molecular and environmental causes for a mental health topic of the student's choosing. We encourage students to choose a mental health topic that is meaningful to them, toward the goal of integrating what they learn in science with their personal lives. The project begins with an anonymous survey where students can share their first thoughts on the project, and questions that they might have about mental health. Results are shared with a mental health professional in our school, who is then invited to spend an entire class period discussing mental health issues, specifically in college students. This focus on mental health shows students that we care about their well-being. Faculty are also fairly honest and transparent about their own mental health history.

The research portion of the project includes various ways to support students in these tasks. There are class periods devoted to finding scientific literature, how to read scholarly articles (at the appropriate level for an introductory course), discussion space for linking ideas across different papers, and peer review. Students are kept on task with intermediate graded assignments.

Most students describe this assignment as one of the most rewarding parts of the course, and one that allowed them to better understand the mental health topics that affect them personally, or those that they love and care about. Essays are oftentimes personal, and researching and writing on these topics can be cathartic for students. The work also allows them to see how Biology content and mastery is related to their personal selves, and therefore why they should care about what they learn. Importantly, because students feel cared for in other aspects of the course, they are more likely to trust us to write personal papers and reveal parts of themselves through these essays.

4. Results

In 2020, Georgetown administered a campus cultural climate survey, using items from the Culturally Engaging Campus Environments (CECE) questionnaire developed by the National Institute for Transformation and Equity [NITE; Georgetown University Office of Assessment and Decision Support, OADS, 2020]. In this survey, URM students reported lower perceptions of care for their well-being and success at Georgetown and consequently lower sense of belonging. Importantly, the same study showed that adoption of more inclusive, culturally relevant and responsive teaching can increase both a sense of belonging and academic achievement of students. Importantly, this correlation between inclusive teaching and sense of belonging is stronger in URM students compared to White Students [Georgetown University The Center for New Designs in Learning and Scholarship (CNDLS), 2021]. This study, along with other studies on the impact of inclusive teaching practices, are the basis of these interventions to build a culture of care for our students.

Overall, student evaluations show that students mostly enjoy this course. Many students mention the importance of their relationship with SAAs, especially their lab SAAs (who they get to work in a small group with the entire semester) in helping them succeed in the course. The retention of students within the Biology Department is high, with overall numbers indicating that the number of students who are Biology majors remain the same throughout all 4 years (currently ~100 per year). The course is not "weeding out" students and is thus providing an opportunity for all students to succeed. Many students also report that the Engelhard independent research assignment is particularly meaningful and reinforces the applicability of scientific content. Prior studies have also shown that this curriculum-infusion increases student's sense of awareness of well-being issues in their own lives and at Georgetown (Finley, 2016).

The importance of that culture of care can also be seen in the number of SAA applications each year. We always have more students apply than we can accept, despite ~50% turnover year to year. When asked why they apply, many students speak of their positive experiences and interactions with SAAs and how their SAAs "cared about me," as well as having a desire to give back to the community.

The scientific skills and knowledge we teach in this course forms the foundation for upper level courses. Critical thinking in a research environment, writing in the discipline, ability to read and understand scientific literature; along with persistence, metacognition, and care for their own learning are skills that faculty and primary investigators rely on. In general, most faculty report that students who have gone through our course are ready for the rigors of further courses in the discipline. The incorporation of more authentic lab experiences are correlated with development of science identities and a more positive perception of laboratory experiences (Esparza et al., 2020).

We still have some ways to go. A small number of students do drop this course due to academic reasons, and they are disproportionately first-generation college students and students who are marginalized in academia. The lower retention of these students is not unique to our course or Georgetown. Factors like college preparation, prior knowledge, culturally relevant academic advising, and student course load has been shown to play a role in student retention (Sithole et al., 2017). It would also be a disservice to not mention that systemic racism plays a role in the impact of each of these factors above and can affect student grades and success (Whitcomb et al., 2021). Various interventions at the level of the institution, college and department strive to provide all of our students an opportunity to succeed. Overall, these efforts have had some success; the graduation rate of first-generation and low-income Community Scholars students at Georgetown is 92%. We still need to do better.

5. Discussion

5.1. Centering a culture of care in F1 centers a culture of care in the department and students

The goal of this paper is to provide guidelines and specific examples on how to incorporate scholarship supported and evidence-based results interventions in a large lecture introductory STEM course; a type of course not usually thought of as inclusive; and to show how to design a course that can provide personal care for each student. In addition, because many of these interventions have been incorporated progressively and gone through many different iterations over many semesters, it makes designing an experiment of this sort difficult. Maybe in the future, a one group pretest-posttest design (pre-experimental design) study could be conducted in order to provide the evidence of the effects of these interventions in emotional and social inclusion perception of students using the Perceptions of Inclusion Questionnaire (PIQ) developed by Venetz et al. (2019).

The impact of building and centering a culture of care in a course is not limited to experiences in the course. We hope to train students who care about developing their own scientific identities, care about the field in which they are a community member, and care about others on the same journey. We hope to train faculty who model the culture of care we expect from students, and to bring that culture to other courses and to their mentorship spaces. We hope to increase student expectations for all their STEM courses and to be more active in the quality and the impact of their own education. We hope to cultivate a culture of care within our department that permeates other aspects of student's education and training. Through this, we hope to train better and more diverse scientists and health professional who can therefore produce better science (Hossain and Robinson, 2012; Bell, 2016).

5.2. Diversifying the teaching team helps all our students succeed

Our faculty are less diverse than the students they teach [National Center for Science and Engineering Statistics (NCSES), 2023]. Part of how we make up for this is by expanding our teaching team; we select SAAs who had their own growth journey, and perhaps struggled initially in F1. This helps our current F1 students see multiple approaches to success, and see their experiences reflected in the teaching team. It reinforces a sense of belonging and STEM identity not only in students, but also in our SAAs. That sense of belonging is crucial for success, and in strengthening the field (Sweeder et al., 2019).

5.3. The need to continue to innovate

We continue to innovate as each year brings new challenges and opportunities. The student body demographics have changed in the years this course has been taught, and the number of students have changed as well. With these changes, new strategies must be incorporated, to not only consider interventions that would help students succeed but to work with the strength of current students. Some of the changes suggested above have been part of our praxis for years, others are relatively new innovations brought about by incorporating ideas by new faculty. The most important tool in evaluating these innovations and designing new ones is student feedback. Each semester we ask students what they liked, and what they wish would change about the course, and whether specific interventions were successful that semester (Supplementary material 6: Student Evaluation Questions). SAA suggestions also form an important part of evaluating the effectiveness of changes. Through these changes, we hope to constantly change the way we teach this course, to fit the needs of the students currently in the course.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1167879/full#supplementary-material

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