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Humanizing STEM education: an exploratory study of faculty approaches to course redesign

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This study presents the findings from the analysis of reflections from 26 STEM faculty at various institutions of higher education across the United States who participated in the online course, The Humanity of Inclusive Practices, part of the Teaching and Learning Academy, offered by the John N. Gardner Institute (Gardner Institute) for Excellence in Undergraduate Education. Participants answered three questions at the end of the online course: what are your equity challenges? What are your goals? How do you measure your success?; we analyzed responses using grounded theory. Findings from this study suggest that student-teacher positionality and inequity in prior knowledge may cause equity challenges for educators. Furthermore, the findings suggest that participants in the course set goals such as increasing student success (grades) in the course, empowering students, and incorporating inclusive material in curricula to humanize their course(s). Lastly, the findings reveal that educators measure their success through grades, as well as student engagement and feedback. Recommendations on how to tackle the challenges associated with humanizing STEM course redesign are provided.

KEYWORDS

STEM education, faculty development, inclusive teaching, equity challenges, reflection, liberatory design, humanizing, implementation goals

Introduction

In this special issue of *Frontiers in Education* we are invited to approach STEM education with a critical and liberatory humanistic perspective. That is, we are asked to consider the societal and human impacts of STEM education and to work toward promoting freedom, autonomy, and empowerment for all students, and especially those from marginalized groups, within STEM fields.

Recently, much has been written about the student disengagement crisis and their lack of motivation (Glazier, 2022). *The Chronicle of Higher Education* published a piece earlier this year underscoring the "Stunning Level of Student Disconnection" (McMurtie, 2022). In recent years, educators have been reporting increasingly high numbers of students not showing up for class or even turning in their assignments. In the piece by McMurtie (2022), an instructor from Nebraska stated that she was unable to describe the level of student disengagement and was at a loss as to help her students learn. No one has an easy answer to why these issues are happening.

Where do we go from here?

As we plan for the changing landscape of teaching and learning in higher education, we face a wicked problem. On the one hand, we are trying to move forward and meet our institutions' educational mission and engage our colleagues and students in learning, and on the other hand we are dealing with the trauma, burnout, and mental health struggles of our students, colleagues, and ourselves. A salient question is: What role does higher education have in ameliorating what some scholars have called this "age of despair" (Grain and Lund, 2016) and improving the human condition? Despair is a feeling of hopelessness, helplessness, and loss of faith in oneself and the future (Batra and Batra, 2022). It is important to remember that behind despair there is pain. Deep and profound pain. When our students are experiencing pain (of loss, of disconnection, of uncertainty), they may also feel despair as they struggle to cope with that discomfort and uncertainty. The relationship between pain and despair can be cyclical, as despair can make it harder to cope with pain, and pain can make feelings of despair worse. As we aspire to move forward and engage our students, it's important to dig deeper into the complexities and nuances of student disengagement. Student disengagement and disenchantment are multi-faceted challenges that require a comprehensive understanding and approach. It is important to consider the various factors influencing this disengagement. Instead, we need a comprehensive, empathetic, and evidence-based approach to addressing the challenges faced by our students.

As we aim to improve and advance our teaching practices to better engage our students, it is important to understand the intricate factors and subtle aspects that contribute to student disengagement. We must be cautious not to simplify or trivialize the issue by attributing disengagement to easy explanations like entitlement, disrespect, or excessive use of social media. We have to avoid rushing to judgment without a thoughtful analysis. It is important that we directly engage our students, listening to their perspectives, and understanding their experiences to identify the reasons behind their disengagement, disillusionment, and lack of interest. In addition to conversing with students and hearing their perspectives, we also need to be talking with and working with colleagues to ensure that teaching practices are meeting the needs of all students. Indeed, faculty members possess the skills and knowledge to adapt and implement teaching practices that promote engagement and participation. In other words, it is critical to foster a collaborative environment among educators, where we can share effective strategies, discuss challenges, and develop innovative solutions.

It is also important for higher education to address the root causes of the "age of despair," such as poverty, discrimination, systemic inequality, and dehumanization, and the role they have played in perpetuation of these systemic inequities. Yet, we must also move beyond investigating the causes to addressing them, and we must move beyond professional development and training to the active promotion of equity and justice through research, policy, and advocacy. One potential role for higher education in ameliorating the "age of despair" is to prioritize the social and emotional well-being of students and faculty, and to center their humanity and agency by focusing on the development of the whole person and creating a culture of empathy and compassion. By taking a holistic and liberatory approach, higher education institutions can not only support the well-being of individuals, but also contribute to the betterment of society

as a whole. Liberatory pedagogy, as described by Freire (1970), is a humanistic approach to education that aims to empower students and help them move toward self-discovery and self-actualization so they may enact social transformation. It is a humanistic approach to teaching and learning because it values the inherent worth and potential of every person and encourages students to relate problems to themselves and their place in the world.

Inspired by the teachings of Freire—as well as hooks (1994) and Rendón (1994, 2009)—and the concept of liberatory design, we, the authors, sought to adopt models and frameworks that would help us move the needle beyond "classic DEI work" (e.g., brief workshops, lectures, or events) that often does not sufficiently permeate course design or redesign. With this in mind, we began working to refine and ultimately reframe an educational development initiative, the Teaching and Learning Academy, or TLA, described in the next section, which is part of existing efforts at the Gardner Institute focused on gateway course redesign.

Materials and methods

The teaching and learning academy

In 2016, the Gardner Institute developed the TLA to support faculty involved in gateway course redesign efforts. Gateway courses are foundational, high-risk (for grades of D, F, W, or I), high-enrollment courses that serve as "gateways" into the disciplines across our institutions (Koch, 2017). For the first 4 years the TLA was offered, participants attended an in-person meeting with sessions focused on various aspects of course design and pedagogy (e.g., inclusive pedagogies, active learning, metacognition, backwards design) and participated in various practice webinars (focused also on pedagogies). In spring 2020, and in response to the COVID pandemic, the authors redesigned the TLA to be delivered online and consisting of the following: an online course, The Humanity of Inclusive Practices; monthly virtual community of practice meetings centered on course redesign through the use of dialogic and liberatory pedagogies (i.e., pedagogies that are centered around social change and transformation), critical self-reflection; and a variety of asynchronous resources.

The online course, The Humanity of Inclusive Practices, has become central to the TLA community and while there is consistency in the foundation and focus of the course, it has evolved each year (now entering the fourth iteration) to be responsive to the context, time, and participants involved. The course is facilitated by a group of fellows, including several of the authors, and it is designed to introduce participants to and engage them in liberatory pedagogy. During a 2-week period, participants learn about foundational concepts and resources designed to help them in their own journey and personal transformation and to support the course design/redesign work they will do. Following are the course outcomes: (1) Develop a roadmap for becoming a critically contemplative and metacognitive educator; (2) Identify elements of liberatory course design; (3) Design mechanisms to assess equity-based teaching and learning practices.

Throughout the synchronous meetings in the online course, we engage participants in discussions designed to validate while challenging participants to continue to self-evaluate through reflective practice. The course culminates in a gallery walk exercise, in which

participants in the course are invited to prepare 1-to-2 slides that respond to the following prompts:

1. What is the focus of your work? (Course, Program, etc.).
2. What is your equity challenge?
3. What outcome or goal are you addressing and why?
4. How will you implement the change?
5. Who are your allies, advocates, challengers?
6. How will you assess the success of your approach?
7. How will you widen the circle of impact?
8. Add a picture, image, meme, cartoon, etc. that represents your TLA journey (in this course).

After the course ends, we continue to engage through monthly synchronous community of practice meetings that allow further and deeper investigation of topics that align with the focus of the TLA and are of interest to the participants (e.g., disengagement, grading, and feedback). Although the structure of the monthly meetings is predictable—consisting of check in and centering activities, presentation on a particular topic, and discussion—the design is also flexible to allow us to be responsive to participant needs in that moment (Imad et al., 2022).

From backwards to liberatory design

The TLA redesign happened concurrently with the death of George Floyd and the rise of Black Lives Matters. Working together to plan for a faculty development program that helped us move beyond backwards design, we were inspired to center contemplative and liberatory pedagogies and design in our efforts to transform the course design processes of TLA participants. This mirrored other calls to provide all students transformative learning experiences, which required action to "intentionally create courses that are anti-racist; utilize elements of affirming, decentering pedagogies; and are culturally inclusive" (Zehnder et al., 2021, p. 4).

In particular, our course used the Liberatory Design framework, which "is the result of a collaboration between Tania Anaissie, David Clifford, Susie Wise, and the National Equity Project [Victor Cary and Tom Malarkey]" (Anaissie et al., 2021, p. 27). This framework was developed at the intersections of design thinking, equity mindedness, and an understanding of the complexity of the challenge to create liberatory and resilient educational systems. Liberatory Design is both "a process and practice" (intended) to:

- generate self-awareness to liberate designers from habits that perpetuate inequity
- shift the relationship between the people who hold power to design and those impacted
- foster learning and agency for those involved in and influenced by design work, and
- create conditions for collective liberation" (Anaissie et al., 2021, p. 1)

In adapting this Liberatory Design framework for the TLA, we emphasized that there are both modes of design that can guide our collective course design practices, as well as mindsets (Table 1) that

TABLE 1 Liberatory design mindsets (adapted from Anaissie et al., 2021). Attribution-NonCommercial-ShareAlike 3.0 Unported (CC BY-NC-SA 3.0).

Liberatory mindset	Description
Build relational trust	Building authentic connection to enable partners to bring their full selves and identities
Practice self-awareness	Acknowledging and challenging assumptions to bring awareness to privilege and oppression
Recognize oppression	Learn to see how oppression has shaped inequitable educational design
Embrace complexity	Being open to the complexity of the challenges, while simultaneously learning what might be more effective
Focus on human values	Listen from a place of love, humility, and respect—honoring the experiences of the communities we work with
Seek liberatory collaboration	Recognize the differences in power and identity to design "with" rather than "for"
Work with fear and discomfort	Identifying sources of, and work through, fear and discomfort, which are anticipated parts of equity design work
Attend to healing	Recognize the trauma (past and current) that comes from equity work, and integrate ongoing healing processes when designing for equity
Work to transform power	Transforming power structures to enable those most impacted to be partners in design
Exercise creative courage	Succumbing to fear and oppression dampens creativity, and we must act courageously to imagine possibilities beyond current inequities
Take action to learn	Low-risk experimentation builds agency and creativity, and helps get past feeling stuck or needing to have all of the answers
Share, do not sell	Invite people into a collaborative process instead of trying to convince them (about process, ideas or perspectives)

can bring an equity-focused self-awareness and intentionality to the course design process.

At the center of the Liberatory Design framework is a requirement for course designers (faculty, instructional designers, and others involved in the course design process) to step back to "Notice" and "Reflect" (Anaissie et al., 2021). By "Notice," the framework implores each of us to understand the educational contexts within which we design our courses and asks us to explore the history of oppression in those systems in order to understand how our existing course and program structures reinforce systemic inequities. And by "Reflect," the framework asks us to be mindful of both our design intentions and our own well-being (individually, interpersonally, institutionally, and systemically) to support healing and transformation (Anaissie et al., 2021). By noticing and reflecting, we can "See the System" to identify our equity challenge(s) that we are designing to address. It is this goal that inspired the core question—What is your equity challenge?—in the gallery walk exercise.

The Liberatory Design framework, developed by Anaissie et al. (2021), uses a six-stage iterative design process—empathize, define, inquire, imagine, prototype, try (see Figure 1). The Liberatory Design

cycle starts with "Empathize," where the course designers (whether faculty or others) create opportunities to try to understand the experiences and motivations of the students and communities with whom you are designing, and empathize with humility, curiosity, love and respect. The second phase of the cycle is "Define," where the course designers begin to look for patterns and insights that reveal the needs of the learners and identify the challenges that the design is trying to address. The third phase of the Liberatory Design cycle, particularly when the design path is not clear, is "Inquire," where the course designers further explore the challenge to better define the design problem. The fourth phase is to brainstorm and "Imagine"—to explore what if—to support creative design options to address the identified learning design challenge. The fifth phase of the Liberatory Design cycle is to "Prototype," where the course designers design versions of learning experiences to test whether the new design is addressing the challenge identified. And the final, and sixth, phase is to "Try" the change—to implement the new design into practice and gather authentic feedback about the impact of the actions implemented on addressing the design challenge. Anaissie et al. (2021) emphasize that not all phases of the design cycle need to be followed sequentially or practiced in a complete cycle.

For the gallery walk exercise, the prompts are intended to lead the participants to ask questions about the courses/programs they are working on that lead them into the phases of the Liberatory Design cycle. For example, the questions—What outcome or goal are you addressing and why? How will you implement the change? How will you assess the success?—are intended to support faculty to begin the liberatory design cycle of empathize, define, inquire, imagine, prototype, and try to address their identified equity challenge.

In addition to the liberatory design cycle, the Liberatory Design framework invites us to foster liberatory mindsets, individually and collectively, that enable us to better center our design process in an equity-focused self-awareness, and design intentionally and collaboratively with the communities most impacted (Anaissie et al., 2021). These mindsets, as described in Table 1, invite us to adopt particular design stances (like creativity, collaboration, reflection, and a commitment to building community) that are rooted in human values (like trust, love, humility, curiosity, and respect).

Within the context of the TLA, through the gallery walk exercise, we invited participants to focus on two of the mindsets in particular: work to transform power and take action to learn. In particular, we asked participants to reflect on identifying allies and advocates
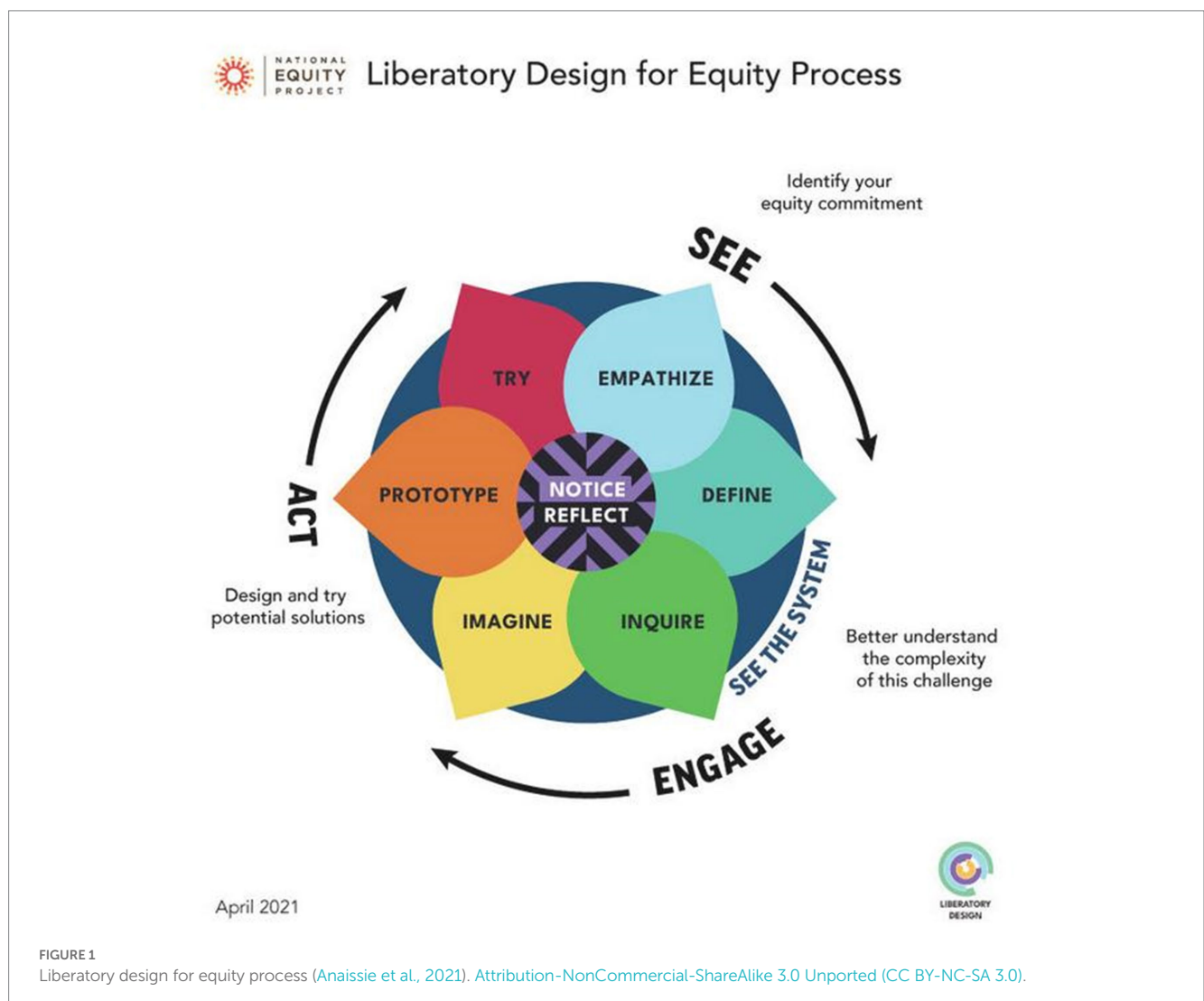

FIGURE 1
Liberatory design for equity process (Anaissie et al., 2021). Attribution-NonCommercial-ShareAlike 3.0 Unported (CC BY-NC-SA 3.0).

who should be invited into partnership and collaboration on the course or program design project identified, as well as the challengers to the goals articulated in the project, in order to transform the dynamics of power that perpetuate inequities. As well, we asked participants to identify an action to work toward, with the goal of encouraging the participants' agency to advance the design process beyond the TLA course.

Methodology

This study involved the analysis of gallery walk submissions from 26 STEM educators who participated in the online course, The Humanity of Inclusive Practice, during 2020, 2021, and 2022. The participants were from a variety of institutions including public, private, liberal arts etc. across the United States (see Table 1). Given the unique focus and approach of the TLA experience, and specifically of the online course, we decided to use grounded theory to allow the analysis of STEM educators' reflections in this exploratory study. Because there is no prior knowledge about this type of program, we determined a grounded theory approach was appropriate as it is best used in small-scale environments where little or no previous research has been conducted (Grbich, 2013). Our intent was to allow the themes and subcategories to freely emerge during the coding process.

One researcher was responsible for coding the gallery walks. Initially, the entire data set was read through, followed by the coder breaking down the data into smaller segments and assigning codes in an open coding process. Subsequently, the coder formed subcategories around the codes and identified core concepts and categories during axial coding. This phase involved creating a clear and systematic coding scheme that reflected the relationships and connections between categories (Charmaz, 2014). Lastly, the coder performed selective coding by grouping related categories to form major themes. It should be noted that the codebook was regularly updated throughout these processes to ensure a comprehensive understanding of each subcategory and major theme.

The analysis of the artifacts produced by the faculty focused on three of the prompts: (1) What are your equity challenges?; (2) What outcome or goal are you addressing and why?; and, (3) How will you assess the success of your approach? The other prompts used to inform the gallery walk submissions were highly context specific, due to the nature of the disciplinary and institutional contexts of the faculty members participating in the TLA.

Participants in the study

The participants in this study, all STEM educators ($n = 26$), comprise a subset of the larger participants in the TLA online course, during 2020, 2021, and 2022. The institutions represented by the participants span a range of institutional types (including private/public; 2-and 4-year institutions), enrollment size, geographic location, and institutional classification, including: Predominantly White Institutions (PWI), Historically Black Colleges and Universities (HBCU), Hispanic-Serving Institutions (HSI), and Minority-Serving Institutions (MSI) (Table 2). Additionally, there are a range of student-to-faculty ratios, which we consulted in this study because a lower

ratio suggests that students have more access to individualized attention from their professors (National Center for Education Statistics, 2018). It is also important to note that in many instances, there were multiple participants from the same institution. As shown in Table 2, most of the institutions represented were 4-year public universities, predominantly white institutions (PWIs), and located on the East Coast of the United States. The average student-to-faculty ratio among these institutions is 13:1. Additionally, five MSI and two HSI institutions were represented, and one participant from an HBCU were among the STEM participants in this study.

It is also worth noting that references to STEM in this study not only includes traditional STEM courses (Science, Technology, Engineering, and Math), but also includes nursing and midwifery fields. In fact, while nursing and midwifery may not be classified as a traditional STEM field, they incorporate scientific principles and skills (mostly biology and chemistry), making it a valuable part of the broader STEM domain. Furthermore, The Bureau of Labor Statistics includes nursing as a STEM field and as STEM-adjacent (BLS Report Card, 2015).

Results

This section describes the themes and qualitative examples that emerged in the analysis of the three selected questions from the gallery walk presentations included in the current study. For the purposes of this section, the questions will be referred to by general thematic area: equity challenge, goals, and success measures.

Equity challenge

Identifying a specific challenge (or challenges) can be foundational to determining and ultimately implementing humanizing approaches, thus, participants in the TLA were asked to elaborate on equity challenges faced in the classroom and during their efforts to humanize their teaching. Specifically, they were asked to consider the following question: "What are your equity challenges?"

Theme one: communication

The most recursive theme in this category relates to communication (Table 3). In this context, communication refers to the relationship between instructors and students, instructor-student positionality, and creating equitable student discussions. This theme includes two subcategories: connecting to first-generation and/or minority students and relating course content to students' real life.

Based on the responses, STEM participants expressed concern about the potential challenge positionality might create in their communication with students. According to participants, in some instances, first-generation and marginalized students' autonomy and self-awareness were repressed, creating communication challenges for instructors. Providing equitable learning opportunities for underrepresented students, particularly those who are working, as well as those who do not have ample access to technology (internet or computer access) are the two challenges that participants mentioned in their responses.

TABLE 2 Institutions represented by participants in the study (College Navigator, n.d.).

College/ university	Private/ public	Size Student-faculty ratio	Community college/four-year college	Enrollment	State	Institution type (PWI; HSI; HBCU; MSI)
Davidson Davie Community College	Public	Small 16:1	CC	3,800	NC	PWI
East Central University	Public	Small 18:1	4-year	3,600	SC	PWI
Georgia College	Public	Medium 17:1	4-year	7,000	GA	PWI
Georgia Tech	Public	Large 20:1	4-year	32,000	GA	PWI
Greensboro College	Private	Small 11:1	4-year	1,000	NC	PWI
Houston Community College	Public	Large 24:1	CC	57,000	TX	HSI
Miami-Dade College	Public	Large 24:1	CC	100,000	FL	HSI
Newberry College	Public	Medium 16:1	4-year	1,000	SC	PWI
Park University	Private	Small 14:1	4-year	11,000	MO	MSI
Southwestern Oklahoma State University	Public	Medium 18:1	4-year	5,000	OK	PWI
University of South Florida	Public	Large 22:1	4-year	50,000	FL	PWI
University of Cincinnati	Public	Large 17:1	4-year	44,000	OH	PWI
University of Massachusetts Dartmouth	Public	Medium 16:1	4-year	8,000	MA	MSI
University of Michigan-Dearborn	Public	Medium 17:1	4-year	9,000	MI	MSI
Valdosta State University	Public	Medium 18:1	4-year	11,000	GA	PWI
Wesleyan College	Private	Small 8:1	4-year	700	GA	MSI
Wofford College	Private	Small 11:1	4-year	1,700	SC	PWI
Xavier University of Louisiana	Private	Small 15:1	4-year	3,000	LA	HBCU

Additionally, STEM participants mentioned relating course content to students' real life as a challenge in humanizing their course content and pedagogy. Given the fact that many courses in STEM have high enrollment, it might be difficult to connect subject matters to individual students' culture, language, history, or context. While it might be impossible to ameliorate this, there are ways to help students begin to establish a personal connection to course content; for example, one instructor teaching Statistical Methods described redesigning an assignment to account for student choice: "Create a long-range project that allows students to pick an area of study while growing their content knowledge." Yet, it is important to acknowledge

that redesigning one assignment might not address the challenge. As one Statistics for Social Sciences instructor described in their gallery walk submission, psychological factors (negative attitudes) can have a significant effect on students' performance: "Math phobia inhibits learning leading to high DFWI rates."

Theme two: students' prior knowledge

The theme "prior knowledge" emerged from the gallery walk submissions from STEM participants, although it was not a theme

TABLE 3 Themes for "What is your equity challenge?"

Theme	Subcategories	Frequency
Communication	- first gen/minorities - relating material to students' real life - financial inequity outside the class	15
Students' prior knowledge		4
Help-seeking		2
Student engagement		2
Students' mindset		2

TABLE 4 Themes for "What outcome or goal are you addressing and why?"

Theme	Subcategory	Frequency
Higher grade	Retention	11
Empowering students		6
Inclusive material		3

across the submissions from the full range of participants, from across the disciplines, over the last 3 years. This theme refers to different levels of students' preparedness for STEM courses and the literature supports this finding. Lubis et al. (2021) in their study showed that students' previous experience does not help them solve STEM tasks, suggesting the presence of deficits in the students' preparation pathway. For example, many students either do not meet the calculus requirements or come to college unprepared with various levels of math knowledge. In one gallery walk submission, a calculus instructor mentioned the following as their equity challenge: "Students coming from different mathematical backgrounds and entering with different mathematical maturity."

In this regard, equity in testing is another challenge for participants. In the context of this study, "equity in testing" is used to capture both the ways in which test questions are developed–ensuring questions are written in ways that are unbiased–and the ways in which students are introduced to the type of descriptive and critical thinking questions in STEM majors. Furthermore, students' different levels of academic preparedness and skill gaps (in study skills, math, or biology) from the beginning of the semester, may further affect their academic performance, thus contributing to the challenge of designing tests and assessments that are equitable.

It is worth noting that participants mentioned other equity challenges with less frequency, but at the same time, these challenges appeared to be emerging, including financial inequity outside the class, lack of inclusive materials (that are written by people of color or minority figures), disinterest in help-seeking, and student mindset. As Table 3 shows, while communication (and its subcategories) along with students' prior knowledge are the most recursive themes in the educators' reflections, help-seeking, student engagement, and students' mindset contribute to equity challenges in this study. According to participants, many students do not seek help outside of class, and engagement in class is limited, making it difficult for instructors to find a ground to communicate with students. Additionally, students' mindsets, specifically when students express fear of a particular discipline or course or demonstrate a fixed mindset (Dweck, 2007), can create barriers which present challenges for instructors as they attempt to communicate with students.

Goals

Participants were asked to set their goals regarding humanizing their courses. They were specifically asked "What outcome or goal are

you addressing and why?" Three major themes emerged from the responses based on their frequencies: higher grades, empowering students, and inclusive materials. Table 4 summarizes the emerging themes and reports on their frequencies.

Theme one: higher grades

The *Higher Grades* theme is used in reference to higher rates of attendance, retention, and pass rates (earning a passing grade in the class). In many courses, student attendance contributes to final grades; therefore, higher grades and attendance are grouped into one category. Furthermore, retention refers to students' persistence to stay in STEM, which is a topic of interest. Retention and higher grades are considered one of the biggest goals for most of the STEM instructors who participated in the TLA. In some reflections, instructors specifically mentioned actionable goals for increasing students' final grades. For example, one computer science instructor set a goal of: "Increase[ing] student success rates to at least 85%."

Theme two: empowering students

Empowering Students relates to a variety of skills, behaviors, and mindsets that STEM participants aim to enhance in students. In their responses, the participants in this study described the following as the criteria to enhance students' achievements: empowering first-generation students, including women; preparing students for effective problem-solving; practicing time management and budgeting finances; facilitating learning for undergraduate Latine students; obtaining higher cognitive engagement; gaining job skills; guiding students to use resources; increasing confidence; practicing planning and organization of tasks; self-advocacy; and reflective learning skills.

STEM participants also described aiming to bridge the gap between prior knowledge and the knowledge students had (related to STEM), increasing students' comprehension of the content, understanding equity for women from different cultures, working on students' cultivation of metacognition, and fostering growth mindset. An illustrative quote from a participant, specifically a biology professor, stated they had a goal to empower their students in their confidence and growth mindset by "Help[ing] students practice metacognition, develop a growth mindset and become more confident learners."

Theme three: inclusive material

Inclusive Material refers to instructors restructuring STEM courses to link materials to students' real life (and therefore making the content meaningful to them), diversifying the course material, including different perspectives on the content, practicing inclusion,

using equity-focused and inclusive design approaches, teaching inclusive comprehensive knowledge, and enhancing sense of belonging. Furthermore, for participants, there was also a goal to enhance student learning or promote learning objectives rather than simply completing assignments.

Related to the diversification of materials, an instructor of midwifery mentioned their goals as follows: "Can include anti-racism in midwifery education toolkit from nurse-midwifery professional organization." Also, another instructor in sport sciences expressed the correlation of the nature of the activities with student engagement: "Student engagement will improve with the addition of more hands-on activities."

It is also important to note that participants highlighted a variety of goals in their reflections. They emphasized enhancing student engagement and fostering supportive communications in their class as two main goals in less frequent fashion. According to participants, supportive communication may rely on improving teacher-student relationships and creating safe spaces for students. Moreover, student engagement may depend on how the materials align with their life or goals. A statistics instructor in the current study framed these relations as follows: "While [the labs] do consist of real-world data that almost always includes topics related to race/class/gender/class, they cannot explore an area of their choice and the data sets are disconnected from one another. I would like them to explore areas that are important to them and allow them to do a deep dive."

Furthermore, an instructor in nursing expressed the importance of creating safe zones for students as a goal: "By facilitating learning experiences that help students feel safe in a psychiatric mental health nursing environment, students will have an opportunity to contemplate and consider their own biases and stigma as it relates to providing nursing care for persons with mental illness."

Finally, participants expressed an aim at fostering a growth mindset in students and through the inclusion of practices focused on self-reflection. Other goals included: nurturing a sense of belonging, creating room for students' feedback, as well as reflection practices and surveys, incorporating real-life situations in the course content, fostering growth mindset, and making the course accessible.

Success measures

Participants were asked to reflect on how they would measure their success in humanizing their teaching. Specifically, they were asked, "How will you assess the success of your approach?" The emerging themes include grades, student feedback, and student engagement (Table 5).

Theme one: grades

Grades was the most prominent major theme in the responses regarding instructors' self-evaluation. The theme of grades refers to

TABLE 5 Themes for "How will you assess the success of your approach?"

Theme	Frequency
Grades	15
Feedback	12
Student engagement	4

students' final grade as well as assessing how much of the course content they recently learned and used in their assignments. As a success measurement, participants may also include the grade comparison of pre-and post-assessment. A sports and exercise science instructor mentioned grades as an indicator of student progression and success: "Student progress toward their degrees and overall classroom performance (i.e., grades)."

Theme two: feedback

Feedback was strongly highlighted in the responses, and it refers to a variety of means of receiving feedback from students. It includes student feedback at the end of the semester, surveys, reflective journals, observations, micro interviews, and student feedback on the course and the respective department. The *feedback* theme appeared 12 times in participants' responses and takes the second rank after grades.

Theme three: student engagement

Based on the responses in the study, it appears that participants may prefer to measure their success in humanizing their course through student engagement. *Student Engagement* refers to participation of students in the discussions, number of conversations in the class, and the quality of discussions. It also includes students' attendance in the class. Student engagement emerged in the data four times.

The other less frequent themes that were mentioned in the responses include retention, perceived empowerment in students, and checking in with students. STEM educators suppose students' retention is an indicator of a humanized course. In fact, the success rate for completion of a STEM course as well as student's progression in their degree programs were expressed as success measures by several participants. Additionally, participants noted the ability of instructors to perceive skills and abilities in their students indicates they have been successful in humanizing their course. According to participants, these skills may include students' perceived physical/emotional confidence, applying skills students learned in the class such as writing and networking, enforcing equitable leadership, composing curriculum vita. Finally, some participants believed that checking to see if students have access to course resources, as well as checking in individually with students, may provide useful tools for measuring their success.

Discussion

While the data analyzed in the current study were limited to the gallery walk submissions from 26 STEM educators who participated in the TLA online course, The Humanity of Inclusive Practices, during 2020, 2021, and 2022, the themes that emerged demonstrate the potential this type of experience can have on humanizing STEM courses.

The findings from this study show that STEM educators may face communication problems with students in humanizing their courses. These problems include educators establishing students'

personal connection to course content especially in large introductory STEM courses, connecting to students with negative attitudes or fears toward the course/major, and specifically, connecting to first-generation and marginalized students. Additionally, some students may not seek help outside class, making it difficult for educators to communicate with students. Moreover, inequity in students' prior knowledge may cause equity challenges for STEM educators. For example, critical questions in tests may be an inequity challenge since students have different levels of preparedness. Effective communication is a key component of liberatory pedagogy. By creating a safe and inclusive classroom environment, using student-centered teaching strategies, communicating clearly and effectively, acknowledging power dynamics, and continuously reflecting and adapting, educators can effectively communicate with their students and promote a more equitable and liberatory learning environment in which students overcome their fears and tend to easily seek help.

Communication with students and their academic prior knowledge are connected in several ways. Effective communication can help educators understand their students' prior knowledge, which can then be used to build upon and enhance their learning experiences. For instance, through effective communication, educators can gather information about students' strengths and weaknesses, which can be used to tailor their teaching approach accordingly. This can help students better understand the material and make meaningful connections between what they already know and what they are learning.

Furthermore, communication can also serve as a tool to activate and engage students' prior knowledge. By using strategies such as questioning, discussion, and reflection, educators may prompt students to retrieve and apply their prior knowledge to new situations or concepts. This can help students make deeper connections between what they already know and what they are learning, which can enhance their understanding and retention of the material.

STEM participants in the study aimed to increase students' final grades and attendance in the class toward the goal of showing students (especially women or minority groups) the power of growth mindset and making them feel confident about themselves through increasing success skills. Furthermore, STEM educators aimed to increase student engagement by linking course content to students' current lives; specifically, decolonizing the course content by including different perspectives. By centering marginalized voices, recognizing multiple perspectives, empowering students, and fostering critical consciousness (which is challenging students to think critically), participants can move toward liberatory pedagogy that values and respects the experiences of all students.

By including inclusive material in their teaching and empowering students to critically engage with it, participants may create a more liberatory learning environment that encourages students to challenge dominant narratives and systems of oppression. Ultimately, this can help students develop a more nuanced understanding of the world and their place in it, as well as the tools and motivation to work toward a more just and equitable society.

STEM participants gage success in the classroom through higher grades and increased student confidence. Furthermore, to

measure their success, participants may evaluate how much of the material students used to complete assignments. While academic performance is not the ultimate goal of liberatory pedagogy, centering marginalized voices and promoting critical thinking and analysis, participants may be able to create a more engaging and inclusive learning environment that supports student success. Additionally, by fostering a sense of agency and empowerment among students, participants may be able to help students take more ownership of their learning and achieve greater success. In liberatory pedagogy, higher grades are seen as a byproduct of engagement and active participation in the learning process, which is facilitated by creating an inclusive and empowering learning environment. Student feedback plays a crucial role in this process, as it allows for ongoing evaluation and improvement of the pedagogical approach, as well as provides opportunities for students to have their voices heard and their needs met. When students feel heard, valued, and empowered in their learning experience, they are more likely to engage with the material and take ownership of their own learning, which in turn leads to higher grades and increased student engagement.

Moreover, to measure their success, educators may rely on students' feedback through surveys, class feedback, and reflective journals. Participants in this study also know they have been successful if they perceive increased student participation in class discussions. Students' empowerment, including physical and emotional confidence, is another measure of success for instructors.

As a follow up to this exploratory study, we intend to conduct virtual focus groups and one-on-one interviews to learn more, specifically, about what participants have done in the context of their course design (Did you follow the plan you developed initially?), challenges encountered, and outcomes of these efforts. We expect some participants will have been successful in their redesign work, while others may have had less success given internal and external variables and pressures, including the current divisive concepts legislation. The nascent results in the current study, as well as those in the planned follow-up study, will be used to further refine the TLA focus and design.

Conclusion

This exploratory study sought to identify themes that emerged from the inductive analysis of qualitative data collected from 26 STEM educators involved in the Gardner Institute's Teaching and Learning Academy. The participants in the study were employed at a variety of institutions across the United States, with the largest representation from PWIs located on the east coast. Although the specific approaches each participant took were unique, common themes around communication, prior knowledge, empowering and engaging students, incorporating inclusive materials, and the importance of feedback, emerged from the analysis of three questions from participant gallery walk submissions at the end of the online course, The Humanity of Inclusive Practices. Findings from the study suggest participants have incorporated liberatory pedagogies and practices into their STEM course redesign efforts toward the goal of humanizing their courses.

Data availability statement

The datasets presented in this article are not readily available because qualitative data collected from individual submissions to a faculty development exercise. Requests to access the datasets should be directed to foote@jngi.org.

Author contributions

MA and SF contributed to conception and design of the study. MA analyzed the qualitative data. MA, SF, MI, and BW wrote the first draft of the manuscript. JC wrote sections of the manuscript. SF worked on the revised version of the manuscript. All authors contributed to the article and approved the submitted version.

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.

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