Enhancing Inclusivity through Alternative Rhetoric in STEM Education

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We report on the outcomes of a pilot workshop for faculty, entitled iSTEAM, focused on enhancing inclusivity and diversity through the integration of alternative and non-Western, non-traditional forms of rhetoric in STEM teaching. Fifteen instructors of STEM courses were invited to revise their syllabi, coursework, assignments and assessment based on a series of four weekly online workshops on non-agonistic (for example, invitational and feminist) rhetoric and how it can be applied in teaching and course development. Online content developed included recorded discussions with leading experts, a set of carefully curated readings, and participation in a cooperative game developed for the program. The first cohort will be invited to help lead activities for a much broader, SUNY-wide version of the iSTEAM program, which will also be expanded to include an additional focus on the impact of non-traditional rhetorical processes on the growing use of generative artificial intelligence (AI) in STEM education.

I.   Background:

iSTEAM, a 2023-24 Innovative Instruction Technology Grant (IITG) funded by the State Univeristy of New York (SUNY), supported 15 STEM instructors across Stony Brook University to make their course syllabi, assignments, and instruction and assessment more inclusive. Participating instructors completed an orientation and three additional modules containing recorded panel discussions, gamified targeted activities, and synchronous meetings where they exchanged their experiences and insights. The project Co-PIs facilitated the exchange, also using a collaborative online game that embodies teamwork and collaboration. A final sympodium will be held this spring, where the graduating trainees will present their experiences and exchange ideas with about a hundred peers from across the SUNY system. In addition, we will share the course, training materials, and resources, through a Creative Commons license to benefit broader SUNYfaculty via the OER resource site for SUNY.

This project draws upon rhetorical/cultural concepts from the arts and humanities to help faculty in STEM fields make learning/teaching more inclusive. To do so, it combines modular

"learnshops," or learning workshops, with gamified learning. The project is invitational in approach, inclusive of diverse knowledge systems, inquiry-based to engage a diverse body of learners, and innovative in its application of culturally-informed pedagogies. In Phase 1 (Fall 2023), we helped the first cohort of STEM educators explore and apply inclusive pedagogies for redesigning their existing courses, enhancing instruction and assessment, and engaging and mentoring students more effectively.

Across higher education, and especially in STEM fields, educators are grappling with a systemic lack of diversity, equity, inclusion, and social justice. Universities have not only struggled to diversify their student populations but also to make their educational practices more equitable [1]-- even before the recent Supreme Court decision and political regression around the country. A new dimension to that struggle is the lack of diversity in the scope of scientific knowledge and its traditions, scientific methods and priorities of inquiry, and application and benefits of science to different groups of people in society and the world. Specifically, mainstream teaching/learning practices, as well as communication and collaboration, scientific inquiry and innovation are not only limited to a Greco-Roman-Anglo-American lineage – which determine the scopes of inquiry and methods for advancing/applying scientific knowledge using agonistic framing as the norm – but also based on patriarchal rhetorical norms of competition, conflict, and conversion [2]. Disciplinary knowledge, including in STEM fields, is founded upon provincial and colonial narratives and is yet to expand into the broader world of scientific inquiry and application. For example, many faculty who teach engineering problem-solving and design typically adopt a "survival of the fittest" approach to selecting one design or solution over another. But framing complex scientific phenomena as debates can be misleading and even harmful. This process also neglects the voices and needs of disadvantaged populations and leads to adopting technological developments that fail to support a wide range of ecosystems, cultures, and communities. This calls for drawing on knowledge traditions and practices from beyond the mainstream.

It is in the context above that the i-STEAM project proposes to address the challenges by creating and piloting a series of online faculty development learning modules that employ gamification. This training project is designed to help STEM faculty draw on knowledge-making and communicative practices of diverse cultures to enhance the design and implementation of courses, assignments, and assessments. Employing rhetorical practices of North American feminist invitational rhetoric, justice rhetoric of ancient South Asia, and African discourse traditions of fairness, the modules are designed to expose and address the pitfalls of mainstream Western persuasive rhetorical practices, which can seem exclusionary or hierarchical.

II.   Project Outcomes and Goals

Faculty who participate in this program, will be able to:

1. Interrogate and disrupt the sociocultural basis of their discipline, drawing upon knowledge and perspectives, discourses and methodologies from diverse cultures. This outcome will be accomplished through discussion and feedback in a community of

learning with colleagues, the use of gamified activities, the revision of teaching artifacts as well as through opportunities for self-reflection on the pedagogies that are traditionally assumed to be the standard for that discipline. This learning outcome encourages participants to look for perspectives that are traditionally excluded and not centered in the hierarchy of knowledge production.

2. Revise their syllabus to reflect the diversity of ways in which communication and collaboration, scientific inquiry and innovation, debate and engagement can be done in a more inclusive society/classroom. This outcome will be accomplished when participants share a current syllabus, choose new readings, craft new activities, assignments and assessments, as well as new models for engaging and interacting with students. Participants will exchange feedback on the updates they've made to their syllabi and will be encouraged to bring a playful note to their course design and to borrow from each other in an effort to bring previously excluded perspectives to their teaching practice.

3. Present and share with a wider audience throughout SUNY. This outcome will be accomplished by the participants' active sharing of new teaching artifacts, multimedia, texts, teaching practices, updated syllabi, activities, assignments, and assessment strategies. Cross-pollination, borrowing from other disciplines, creative and critical pedagogies will be emphasized in this learning outcome. The faculty development program itself and its resulting resources will be shared throughout SUNY via Brightspace (our chosen learning management system) with a Creative Commons license so that others may use it to train their own faculty members. It will also be shared via the SUNY OER repository of course materials.

III. Program Features

Addressing the pitfalls of traditional bivalent/binary framing of discourse, our training uses what we call the four I's: invitational, inquiry-based, inclusive, and innovative. The **Invitational** approach to classroom instruction is based on foundations of feminist rhetoric and discourse [2], which build upon the principles of self-worth, equality, and agency. Our training helps participants counter the subtle and normalized traditional discourse that seeks to prove others wrong, silence or suppress marginal voices, and talk over those who lack power and privilege in knowledge or language. The training will help faculty use **inclusive** approaches, including ideas from different knowledge systems as a condition for effectiveness and success. It will use **inquiry-based** teaching that seeks out divergent and creative thinking [3] . And, finally, **innovation** is the fourth leg of our methodology, defined not simply as novelty but creativity with purpose, connected with diversity and equity, inclusion and justice.

Collaborative Game: Using game elements to engage participants in non-game contexts has been proven to effectively increase motivation, engagement, and performance among learners [4]. Games that are collaborative are especially effective for helping students work together to solve common problems [5-7]. For this project we developed an online collaborative game that

harnesses community, collaboration, and constructivist learning (rather than conflict and competition) as features of gamified/playful learning. This game, which we call "It Takes a Village", has players work together to restore a war-torn village to sustainable functionality with the help of a group of volunteer villagers (non-player characters in the game). Because each player has different expertise, and therefore different skills, each player is equally important in achieving this goal before the winter sets in. This is designed to reinforce the importance of the four I's, showing that DEI can lead to better scientific and technical outcomes. Participants played this game during the learnshop, and were encouraged to adapt it for use in their own classrooms.

Program design: This is an online four-module faculty development program. Each module contains a set of **read-watch-do** and activities that participants complete within a week. At the end of each week, participants meet in the virtual "exchange workshop," where course instructors facilitate presentation and exchange of ideas/experiences. We also pair participants for connection during the week, based on adult learning theory [8] that shows learners are motivated by testing out new ideas as they co-construct knowledge in a community [9]. This ongoing collaboration will include gamified challenges that help participants practically experience inclusive educational practice.

> *Orientation Module: Learning the concepts and approach*: Through foundational readings, discussions, and gamified collaborative activities, participants become familiar with each other and the theories and principles that inform this program. They will share a current syllabus that they plan to update as they move through this program. Like the modules, the orientation includes a synchronous discussion. Participants play the collaborative online game, exploring the diversity of ways in which communication and collaboration, scientific inquiry and innovation, debate and engagement can be done more inclusively, without conflict/competition.
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> *Module 1: Updating a course syllabus*: Participants update an existing course by interrogating the sociocultural basis of their discipline, drawing upon knowledge and perspectives, discourses and methodologies from diverse cultures. They exchange feedback on the updates they've made to their syllabi.
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> *Module 2: Updating assignment design and assessment plan:* Participants reflect on and challenge dominant assumptions and norms in learning and assessment. They revise one or more assignments and assessments of learning.
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> *Module 3: Updating instruction and student engagement strategies:* Participants apply invitational, inquiry-based, inclusive, and innovative teaching/learning strategies to their teaching practice. As such, participants create artifacts, multimedia, or texts that demonstrate the importance of disrupting power, acknowledging diversity, ensuring equity, enacting inclusion, and effecting justice in/through their instruction and interaction with students.

Participants, having worked with and played the online game developed for the workshop, discuss application of the game to their students and classes.

Module 4 (Presentation)*: **Sharing experience with a broader audience:*** Participants, who have applied their updated syllabi, assignments, teaching and assessment strategies during fall 2023, will share experiences and resources at a Zoom event in late spring 2024. We will start/frame the conversation by sharing the training model. The audience will be STEM faculty from across SUNY.

IV. Feedback from Initial Cohort:

Our initial cohort of 15 faculty/instructors are associated with two engineering departments (two from Biomedical Engineering, three from Materials Science and Chemical Engineering), several departments associated with the medical school (he Department of Family, Population and Preventive Medicine, the Department of Physical Therapy, and the School of Nursing), as one each from the Department of Biology, the Sustainability Studies program, the Department of Sociology, and the College of Engineering and Applied Science undergraduate advising office). All participated in the full four weeks of meetings, readings, video discussions, and online synchronous meetings, as well as the post workshop activities. A number of participants specifically mentioned in feedback on the program the value of having a group of workshop leaders and participants representing a wide range of STEM disciplines.

When asked "How much time did you spend, approximately, per week during the workshop on readings, videos, preparation, and any related activities, in addition to the weekly meetings?", 70 % indicated that they spent 1-2 hours per week, and 30% reported spending 3-4 hours per week. This is in line with what was expected for the workshop. When asked how many students will be impacted through the end of the Spring 2024 semester by the program through participants' revisions of their syllabi, courses, teaching, and assessment, 40% responded 0-50, 40% responded 51-100, and 20% responded 101-200. Taking average values in these categories, just those responding to the survey will impact about 700 undergraduate students.

Participants were asked, on a likert scale, how valuable they found the program components and activities. The chart below shows some of their responses concerning program activities.

Scale numerical values:

5: "It was very useful. I loved it"
4: "It was useful. I found it beneficial."
3: "Neutral"

2: "It was not useful. I was not worth the time."
1: "It was not useful … did not try, did not read, etc."

Program element	Average score	% who felt it was useful or very useful	Comments
Orientation module overall	4.8	100	
Orientation readings	4.7	100	Reigle-Crumb, Persistence Gap [10]; Johnson, Implementing inclusive practices [11]
Word cloud	4.3	100	Participants create and share a Word Cloud for their current syllabus, identify and share words which may impact inclusivity negatively
Online game	4.0	70	See description of game in text
Module 1 overall: Reviewing/revising syllabus for inclusivity	4.6	90	
Module 1 readings	4.6	90	Fujii et al., Promoting EI in STEM curriculum design [12]; Bailin & Battersby, Beyond the boundaries [13]; Kwapisz, We've always been engineers [14]
Module 1 video discussion	4.3	90	With invited external experts
Module 1 activity: Auditing and tracking changes in syllabus	4.7	100	Participants audit and identify changes in syllabus; share with other participants
Module 1 synchronous	4.8	100	Meet with workshop leaders; participate

weekly zoom meeting			in breakout room discussions
Module 2 overall: Revising assignments	4.7	90	
Module 2 readings	4.5	90	Foss and griffin, Beyond persuasion; Pitso, Invitational pedagogy
Module 2 video discussion	4.5	90	With invited external experts
Module 2 activity: Revising an assignment	4.5	100	Participants use lessons learned from readings and video to revise an existing assignment
Module 2 synchronous weekly zoom meeting	4.8	100	Meet with workshop leaders; participate in breakout room discussions
Module 3 overall: Enhancing teaching	4.7	100	
Module 3 readings	4.3	80	Bowen, Is your math course racist? [15]; Boston U of Medicine, Ensuring inclusivity [16]
Module 3 video discussion	3.9	80	With invited external experts
Module 3 activity: Creating inclusive teaching strategies	4.5	90	Participants develop inclusive teaching strategies for their courses; share with group
Module 3 synchronous weekly zoom meeting	4.4	90	Meet with workshop leaders; participate in breakout room discussions

Note: Module 4 (Symposium of results from Spring semester, to be held in May, 2024).

Clearly, participants in the initial cohort for the most part found the content of the program to be very beneficial to their teaching and to the development of a more inclusive teaching methodology. Below are some selected general comments from participants in the program:

"I found the iSTEAM Project very diverse in its components, and interactive. I liked the fact that we were provided with readings to assist in making actual changes to our syllabus and assignments. This forced me to get the job completed and be prepared for implementing the changes I made at the start of the new semester. I liked the clear list of tasks to complete each

week and interacting with a diverse group of STEM faculty from West campus. It provided a variety of helpful perspectives."

"Very enlightening and practical at the same time."

"I think this was overall a great workshop series. I wish we had more time for discussion and for the game. I think things would have gone over more smoothly if the game manual was given and required to be looked at before we started playing. I think discussion about how this game or ones like it can be incorporated or how it can help develop more inclusive learning would have been helpful. I also would have liked to hear from others about how the game fostered inclusive learning ...."

"I really enjoyed the weekly meetings and the breakout rooms during that time. I felt that I got the most out of the workshop when I heard other people's opinions and how their classes are run."

"People, especially "established" lecturers, would be very skeptical about a STEM education workshop, as they (we) may say "I KNOW HOW TO TEACH". But this workshop is NOT focusing on HOW TO TEACH but on HOT TO EDUCATE people (student, audience, participants, etc.)."

"I liked that the workshop required faculty to make changes to various components of our course and not just think about them. I also appreciate the fact that we got to share and discuss our changes with faculty from other programs. This sharing provided me with other ideas to include in my course changes."

"The training from this workshop will have a very positive impact on my teaching. Going forward, I will be adopting a more inclusive pedagogy in all of my courses."

More specific comment reference particular workshop components include:

"I learned quite a bit by reading papers, but it was the discussion with colleagues that was most illuminating. In particular, the influence of language in syllabus on students' perception of the DEI efforts in class was an eye-opener."

"Since the workshop required us to make changes to our syllabus and modify our assignments, I am prepared to implement changes next year in this course. I also plan on making similar changes using what I've learned through the workshop in my spring course. I have a very clear understanding now, that a number of small changes to promote inclusivity can lead to a larger change in the culture within the classroom, and am very happy I participated in the workshop."

"The sections that impacted mostly my teaching were the ones referring to "reviewing syllabus" and "updating assignments". They helped me emphasize more on inclusivity and diversity for my courses. "

VI. Conclusions and Future Plans:

The workshop modules were well-received and found by participants to have enhanced their ability to develop a more inclusive course structure and learning environment through integrating concepts from non-western, feminist, and non-agonistic forms of rhetoric. While the final symposium showcasing STEM instructors' revision of courses and discussing impact on students has not yet been held, it is clear from surveys and submitted work on syllabi and assessments that revisions of language, design of inclusive class activities, attention to aspects of diversity and inclusion in assessment of learning gains, and exploration of gamified activities which reflect problem-solving which leverage cooperative learning and alternative forms of rhetoric, have had a positive impact on both teaching philosophy and development of a more inclusive environment.

Phase II of the program will involve a larger cohort of participants selected from institutions across SUNY. In addition to building upon the lessons learned from the first cohort (many of who will serve as facilitators for the phase II activities), new material exploring the role of artificial intelligence in teaching and learning, and in particular the impact of AI on rhetorical methods in STEM education, will be added to the program. These materials will be integrated throughout the workshop modules, and will be the focus of additional readings and discussions. An AI focused activity which demonstrates the impact of forms of rhetoric used in generative AI responses will also be employed to build on readings and reinforce related concepts for the participants.

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