THE SOCIAL DIMENSIONS OF STEM CULTURE: HOW DOES LACK OF DIVERSITY AND INCLUSIVITY AFFECT A STUDENT'S SOCIALIZATION?

Honors Thesis

Presented in Partial Fulfillment of the Requirements
For the Degree of Bachelor of Science in Chemistry

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By

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Abstract

Diversity and inclusivity matter in STEM and without them, STEM would fall apart. In the United States, Latine and African American students are severely underrepresented in STEM fields and they obtain fewer STEM degrees compared to their white counterparts (Hall, Nishina, Lewis 2017). The reasoning behind this can be due to societal, social, individual issues, or ethnic discrimination affecting retention rates, academic outcomes, self-efficacy, and one's socialization (Wiedemann 2019)(Estrada 2021). Students and educators need a sense of belonging, experiences of love and kindness to be able to thrive in the rigorous STEM environments, regardless of their diverse backgrounds. For many, the COVID-19 pandemic has caused a lot of stress and only increased this need as students are working from home, "juggling pets, children, elderly relatives, economic pressures, unstable internet, health disparities, political unrest, climate disruptions, racism, violence, and death" (Estrada 2021). While efforts are being made to reduce this large disparity in STEM, it is not enough. Trends can also be seen at Salem State University (SSU). This study will describe a study that is a preliminary attempt to understand how SSU can foster a more inclusive STEM environment for minorities and how students can find support from others like themselves. This study employed a mixed methodology to explore SSU STEM majors' sense of belonging, and how that intersects with facets of students' identity including race, ethnicity, and gender. Current students were asked to fill out an anonymous survey on their sense of belonging, experiences at SSU, and how well students feel that they are supported. Results from analysis of the survey responses indicate that 40% of STEM majors expressed at least some doubt of their belonging and many STEM majors do not feel like they belong, especially if they are from backgrounds underrepresented in STEM.

Indigenous Acknowledgment

"This land is Naumkeag, or fishing place, where generations of Indigenous peoples lived and passed through for centuries. From the village upon the Naumkeag River (now known as the North River) to Sachem Nanepashemet's fortification (now known as Castle Hill), the people of Naumkeag farmed, fished, traded, raised families, discovered and invented, created art, and, above all else, honored the lands upon which you stand today. We acknowledge that this is Indigenous land and also acknowledge the Massachusett Tribe, who continue to honor and hold this land into the present" (*Native history and indigenous acknowledgement from Salem, MA* 2023).

As part of our commitment to diversity, equity, and inclusion, we recognize our responsibility to this land and acknowledge our need to include Native people and perspectives in all of our endeavors.

Acknowledgements

First and foremost, I would like to express my warmest thank you and appreciation to Dr. Luke Conlin who made this work possible and for providing me the opportunity to conduct my research with him. This endeavor would not have been possible without his ongoing mentorship, guidance, and advice. His approach to combating this thesis has been valuable to me and has played a massive role in the success of writing my very first thesis.

Special thanks to Dr. Scott Nowka, Chair of the Commonwealth Honors Program, and the Salem State University Commonwealth Honors Program for all the resources and support they provided.

Lastly, I would like to thank all of the participants in my research study for their time and willingness to share their experiences on my survey. This work would not have been possible without their contribution and I appreciate it greatly.

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Introduction

People of color, particularly women, are underrepresented in STEM fields. Diversity matters in STEM and without it, STEM would fall apart. In the STEM field, ethnic minority students are severely underrepresented, and in the United States, Latine and African American students are shown to obtain fewer STEM degrees compared to their white counterparts (Hall, Nishina, Lewis 2017). The various reasoning behind the lack of minority students in STEM can be due to societal, social, individual issues, and/or ethnic discrimination (Hall, Nishina, Lewis 2017). This can affect retention rates, academic outcomes, self-efficacy, and socialization (Hall, Nishina, Lewis 2017).

Many students can feel and question their belonging in STEM and students need to have more "ethnically diverse peers, as it can promote positive, social and academic outcomes in undergraduate institutions" (Hall, Nishina, Lewis 2017). This can improve retention rates and foster a more inclusive STEM environment. It causes students to engage more with diverse backgrounds and "when it comes to ethnic minority students' involvement in STEM, general friendship has been found to have a direct effect on a student's perception of STEM fields and attitudes about achievement" (Hall, Nishina, Lewis 2017). Diversity and inclusion are needed for all kinds of students and faculty to survive and to be able to thrive in that rigorous environment (Wiedemann 2022). According to Wiedemann, "Diversity drives innovation, diversity makes us adaptable and diversity even makes us smarter. A lack of diversity in STEM would lead to fewer discoveries, which means fewer, and potentially less viable, solutions to humanity's most pressing problems. Without diversity, we cannot harness the full potential of STEM. That is a strong enough case for diversity being relevant to STEM, but there is more. Recent examples of how artificial intelligence amplifies biases from the real world very clearly highlight the need for

diversity in STEM. The people working in STEM professions need to represent the people using STEM products and services – they need to be representative of society as a whole" (Wiedemann 2022)

Diversity categories may come from differences in gender, disability, race, ethnicity, nationality, sexual orientation, age, religious status, and cultural status (Rollins 2022). There are a large number of categories that can advertise a variety of people, and yet, the STEM field is dominated by almost all white male counterparts (Rollins 2022). According to Rollins, the percentage of the STEM workforce is 89% white and 72% male as stated by the National Science Foundation. This percentage in the STEM field does not accurately or currently reflect the diversity in the United States because right now, there are more "non-white children than white children, and nearly half of all children born are female" (Rollins 2022). Without this variety of diverse people, this can negatively impact a student's academic success, grades, the value of education, academic motivation, and self-doubt in their abilities in STEM (Rollins 2022). By creating a more inclusive environment, limits discrimination and educates on the implicit and explicit bias. This idea achieves greater diversity as there is an increase in the workforce and education with different experiences and perspectives (Rollins 2022). It is shown that a lack of representation in faculty members and educators can affect a student's socialization and cause denial and overwhelming emotions to be one of the first minority students in an educational program or job position in the workforce (Rollins 2022). This issue can be intimidating for students, employees, and educators because of the lack of cultural awareness and questions about one's belonging in a STEM program (Rollins 2022). In times like these, students from underrepresented backgrounds need experiences of love, kindness, and a feeling of belonging regardless of their diverse backgrounds (Estrada 2021). For many students, educators,

and people as a whole, *Coronavirus disease 2019*, has caused a lot of stress, and headaches, and changed people to yearning for more compassion and kindness. Students and educators are working from home, while "juggling pets, children, elderly relatives, economic pressures, unstable internet, health disparities, political unrest, climate disruptions, racism, violence, and death" (Estrada 2021). At the expense of people choosing to be more inclusive, and kind, and increase representation to the world can be a benefit to the student's learning and satisfy a basic human need for, "'self-actualization,', which Maslow defines as the "acceptance and expression of the inner core of self" (Estrada 2021).

Given the research that has been reviewed, the thesis' goal is to answer these questions: Why do diversity and inclusivity matter, and why is there a lack of it in STEM fields? How does this inclusion affect students' socialization and intersect with students' race and gender? How do students from underrepresented backgrounds find support and connect with others in STEM fields at Salem State University and how can we shift STEM culture at Salem State University and beyond to foster a more inclusive STEM environment?

If we want to support women and people of color in STEM, we have to start by understanding their experiences. Shifting STEM culture to foster inclusivity is crucial for students from underrepresented backgrounds. I designed and implemented a sense of belonging survey to explore, which I will detail in the next section.

Methods

This study employs a mixed methods design. Current STEM majors were asked to fill out an anonymous survey on their sense of belonging, experiences at SSU, and how well students feel that they are supported. At the end of the survey, there is an option where students can participate in a personal interview to learn about their experiences on campus.

Survey design

The survey was informed by a literature search of other research studies that explored a sense of belonging among students from different backgrounds (Rainey, Dancy, Mickelson, Stearns, & Moller, 2018).

Page 1 of the survey asked demographic questions such as class year, Major(s), racial/ethnic identity, gender identity, disability status, and first-generation student status.

There were a couple of important considerations in asking these questions. First, responses were non-exclusive: They could pick multiple ethnicities, genders. Second, there was no forced choice: they could choose not to answer. This is important for confidentiality to protect the identities of students who may be one of only a few members of that identity within their department.

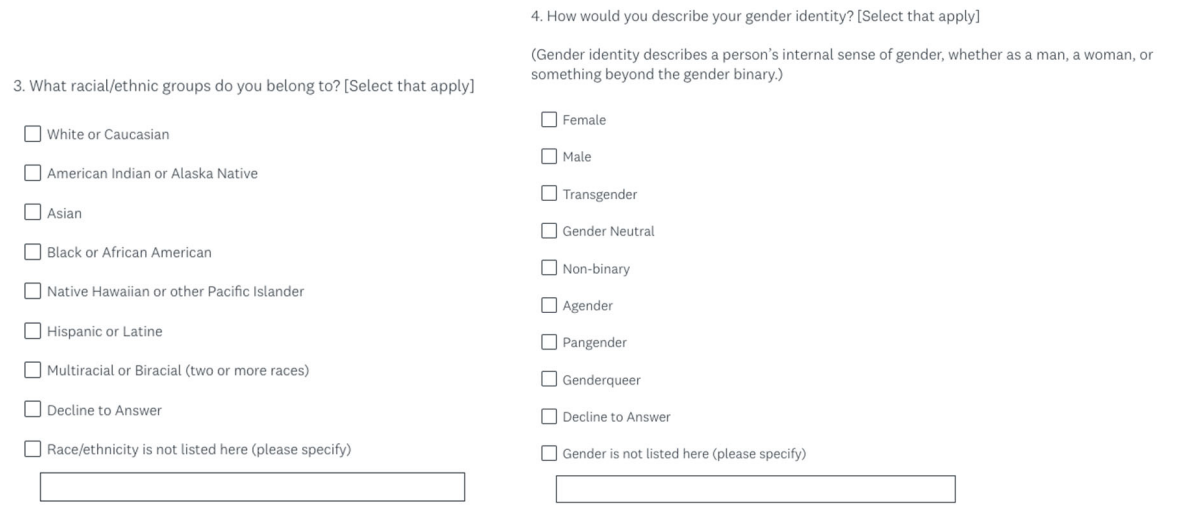

Figure 1. Demographics questions with non-exclusive categories.

The survey then asked questions about students' sense of belonging. Some questions had open-ended responses, such as whether they felt like they belonged in their STEM Major (Q7 in the Appendix). Open-ended responses to this question were coded for valence into three categories: "Yes", "No" and "Mixed response". Other questions had Likert-scale responses, ranging from "strongly disagree" to "strongly agree" (Q8 and Q9 in Appendix).

Recruiting Participants

I wanted to hear from the majority of STEM classifying majors with intersecting identities like gender, sex, ethnicity, race, religion, and disabilities/accessibility. I recruited participants by creating flyers to send through email, sent emails to department chairs to send to students and faculty to fill out, social media, and word of mouth. Response rate was low, so I created the option to get incentives in response to filling out the survey if students signed up for focus groups and personal interviews.

Results

3.1 Demographic responses

There were 69 respondents who answered at least the demographics questions and the analysis includes only responses from those who completed the survey. There were 45 respondents from 8 STEM majors that completed the survey. Respondents were mostly white (64%), female (71%) and approximately half were 1st generation college students.

3.2 Sense of belonging responses

One key finding was that 40% of STEM majors expressed at least some doubt of their belonging (Q7).

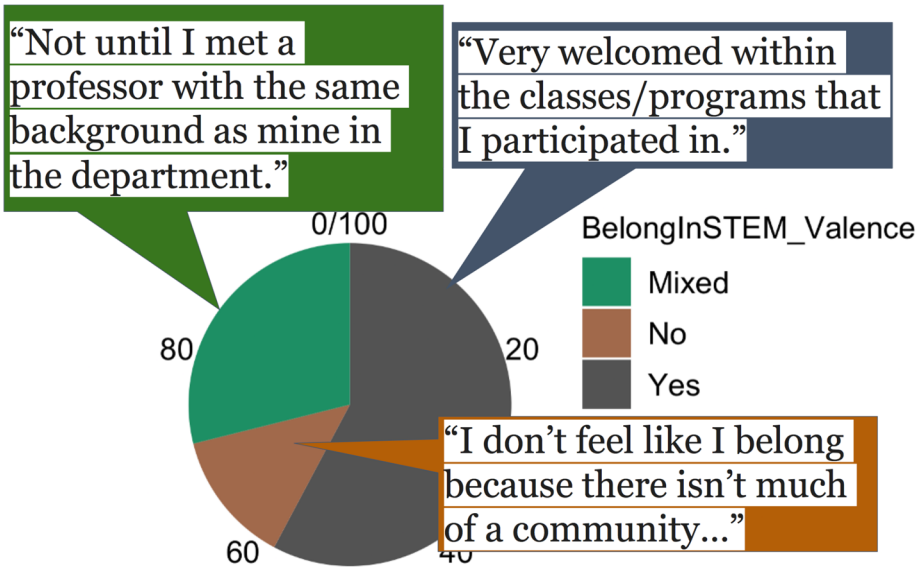

Figure 2: Pie chart of the responses to "Do you feel you belong/belonged in your STEM major", split out by valence (Yes/No/Mixed) with quotes from each category.

Another key finding Non-white students were more likely to say they do not feel they belong in their STEM major (4/12=33%) compared with white students (1/18 = 5.5%). A chi-square test was statistically significant: X2 (1, N = 30) = 4.00, $p < 0.05$.

Acknowledging these results can help address a students' lack of sense of belonging as it is vital for their well-being, academic success, retention, and socialization. By recognizing and responding to these concerns, educational institutions like Salem State University can create a more supportive and inclusive environment for all students and faculty.

Contingency Tables

	White		
BelongInSTEM_Num	0	1	Total
-1	4	1	5
1	8	17	25
Total	12	18	30

Figure 3: A contingency table of responses to Q7 as belonging in STEM (1) or not (-1), split out by whether they identified in Q3 as White (1) or not (0). Out of the 5 who said they did not feel they belonged, 4 were Non-white and only 1 was White.

Discussion

The goal was to conduct focus groups and personal interviews with students. With low response rate meant more time was needed to recruit survey respondents, thus leaving too little time to conduct and analyze interviews. The next steps would include presenting and sharing these results with the University administration to possibly increase or change our diversity, equity, and inclusivity (DEI) training and policy. As well as to point out pitfalls and trends shown in literature research at other universities to watch out for as Salem State University plans to be a Hispanic Serving Institution (HSI) and Minority Serving Institution (MSI). I would personally recommend promoting and marketing the support resources we have here on campus as many students are unfamiliar with these resources. We as students are transitioning into other forms of communication and email may not be sufficient to read everyday as there is an increase of emails incoming from various places. Establishing mechanisms for feedback and ongoing support for these resources on campus is necessary to improve the lives of students and incorporate different perspectives across academic disciplines. Possibly sending regular newsletters or emails to students can be an effective way to notify them about the resources on and off campus. These newsletters can provide updates about the university, student success stories and reminders of deadlines or various campus activities. Leveraging social media platforms like Facebook, Instagram, Twitter, LinkedIn, and Tiktok is beneficial as that's where the majority of students follow and keep up with. It is important to remember to have multiple approaches to ensure maximum visibility for the promotion of university resources to students.

The next step would be resource allocation to be able to dedicate resources to funding, staff and facilities to address the lack of diversity and enhance student socialization. It could be beneficial to recruit cohorts of STEM majors, particularly from underrepresented groups, and

create a support system with ways to get scholarships, programming, research centered on opportunities to get experience within their field of study.

Despite the efforts being made, the university still lacks diverse representation among its students, faculty, staff and leadership; it could impact the future DEI initiatives in place. If the university has a more diverse representation of its community, those from underrepresented groups can provide role models and mentors for students. Beyond formal initiatives and rules, it all stems from an inclusive campus climate with everyday interactions and behavior of the university community within the students, faculty, staff, and administrators. It is important to continue ongoing support and accountability to address instances of bias, discrimination or exclusion that occurs on campus as it can create an unwelcoming environment and impact a student's sense of belonging.

From my perspective, I appreciate that the university is taking action to address this issue of lack of diversity, equity, and inclusion (DEI), and being able to acknowledge its impact on students. This research has shown that and can inform the university's decisions moving forward.

Conclusion

In summary, the responses to the survey indicate that many STEM majors do not feel like they belong, especially if they are from backgrounds underrepresented in STEM. We need to study what factors associate with a sense of belonging to help STEM departments make all students feel they belong in a rigorous environment. Overall, while the university's effort to address the sense of belonging, it is important to continually assess and improve its strategies to ensure meaningful and lasting change as our cohort of students constantly evolve.

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Appendix: Sense of Belonging Survey

Inclusion and Sense of Belonging as a STEM Major at Salem State University Survey

About You and Your Demographics

Your individual responses will be kept anonymous and your participation in this research study is voluntary and optional.

Topics: Sense of Belonging, Race, Gender, Intersectionality, Thesis, Salem State University

1. What is your class year or standing? [Select one that applies]

- ◯ First Year
- ◯ Sophomore
- ◯ Junior
- ◯ Senior
- ◯ Graduate Level or Higher
- ◯ Other (please specify)

2. Your Education

Major(s)	
Concentration(s)	
Minor(s)	

3. What racial/ethnic groups do you belong to? [Select that apply]

- [ ] White or Caucasian
- [ ] American Indian or Alaska Native
- [ ] Asian
- [ ] Black or African American
- [ ] Native Hawaiian or other Pacific Islander
- [ ] Hispanic or Latine
- [ ] Multiracial or Biracial (two or more races)
- [ ] Decline to Answer
- [ ] Race/ethnicity is not listed here (please specify)

4. How would you describe your gender identity? [Select that apply]

(Gender identity describes a person's internal sense of gender, whether as a man, a woman, or something beyond the gender binary.)

- [ ] Female
- [ ] Male
- [ ] Transgender
- [ ] Gender Neutral
- [ ] Non-binary
- [ ] Agender
- [ ] Pangender
- [ ] Genderqueer
- [ ] Decline to Answer
- [ ] Gender is not listed here (please specify)

5. Do you identify as a person with a disability or a person with accessibility needs?

- ◯ Yes
- ◯ No
- ◯ Decline to Answer

6. Do you identify as a First-Generation Student?

- ◯ Yes
- ◯ No
- ◯ Decline to Answer

Inclusion and Sense of Belonging as a STEM Major at Salem State University Survey

About Your Experience Here at Salem State University

7. Do you feel like you belong/belonged in {your STEM major}? [Please explain]

8. Campus Climate and Sense of Belonging

	Never	Rarely	Occasionally/Sometimes	A moderate amount	A great deal
How connected do you feel to the university faculty/librarian/staff at Salem State University?	○	○	○	○	○
How welcoming have you found Salem State University to be?	○	○	○	○	○
How much respect do other students at Salem State University show toward you?	○	○	○	○	○
How much respect do members of university faculty/librarian/staff at Salem State University show toward you?	○	○	○	○	○

9. General and Social Belonging

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
I feel comfortable being myself at this university	○	○	○	○	○
I am proud to be a student at this campus	○	○	○	○	○
I feel that I make a meaningful positive contribution to the experience of others within the Salem State community	○	○	○	○	○
I feel safe, while at school	○	○	○	○	○
I feel well supported at school as I strive to meet my potential	○	○	○	○	○
There is at least one trusted adult I can talk to at school	○	○	○	○	○
I have considered leaving Salem State, because I felt isolated or unwelcomed	○	○	○	○	○

10. Have you, personally, been affected by experiences of discrimination at this university?

- ◯ Yes
- ◯ No
- ◯ Decline to answer

11. If yes, on what basis have you, personally, experienced discrimination at Salem State? Please check as many as apply.

- ☐ Race
- ☐ Ethinic origin
- ☐ Religion
- ☐ Gender identity
- ☐ Sexual orientation
- ☐ Political status
- ☐ Socio-economic status
- ☐ Option is not listed here (please specify)

12. Do you have any suggestions on how to increase/enhance your sense of belonging at Salem State?

13. Is there anything else you would like to say or add? Please feel free to add any other comments in the space below.

Comments	
Suggestions	
Concerns	
Questions	

Inclusion and Sense of Belonging as a STEM Major at Salem State University Survey

Research Experience Questions

14. Which research experiences have you participated in while you have been at Salem State (Select ALL that apply)

- [ ] In-class research projects (searching literature and online sources)
- [ ] In-class research projects (collecting and analyzing data to answer a question)
- [ ] Out-of-class research (working with an SSU professor to conduct research)
- [ ] Out-of-class research (working with a research mentor outside of SSU_
- [ ] Out-of-class research (paid internship)
- [ ] Out-of-class research (unpaid internship)
- [ ] Out-of-class research (Self-directed research project)
- [ ] No research experiences

15. For how many semesters/courses have you been involved in research?

0 20

16. How did you find out about the research opportunity? [Please explain]

17. Have you been interested in gaining research experiences?

- ◯ No
- ◯ Yes, but I don't know how to get involved
- ◯ Yes, and I know how to get involved. I just haven't done that yet.

Inclusion and Sense of Belonging as a STEM Major at Salem State University Survey

Interviewing For More

Thank you so much for participating in this important survey. We are interested in hearing more about your experiences here at Salem State University. You can participate for a chance to win a $25 gift card!

Would you be open to an optional interviewing afterward for us to learn more about your experiences? Please CLICK HERE and it will populate an automatic email to Dr. Luke Conlin and Gisady Mendoza.

PLEASE NOTE: to ensure your confidentiality, your information will be stored in a separate database from your previous survey responses and will not be linked.

Campus Resources

SSU 24/7 Mental Health Support Line (978.542.8327): The line is confidential and available 24/7 for all Salem State students who need access to after-hours or urgent mental health support on a variety of issues. Find additional wellness information and resources here.

PEAR Office: The Prevention, Education, Advocacy, and Response Program is dedicated to the prevention of sexual assault, dating, domestic violence, and stalking. PEAR provides programs, training, workshops, and discussions on consent, healthy and unhealthy relationships, gender and sexuality, masculinity, bystander intervention, and more. For more information, please email PEAR@salemstate.edu.

Center for Justice and Liberation serves as a comprehensive collaborative community space that honors, centers, and advocates for the holistic development and retention of students of underrepresented, marginalized, and stigmatized identities due to oppressive structures.
Ellison Campus Center Room 202
Hours (Fall 2022)
Monday-Friday, 12-5 pm