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“Anyone Can Be a Scientist”: Examining the Influence of Diverse Scientist Representation on High School Students’ Perceptions of Science and STEM Careers

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Abstract

This action research study examined how implementation of diverse instruction of scientists within a secondary astronomy course could affect students' perceptions of scientists and Science, Technology, Engineering, and Mathematics (STEM) careers. The study also looked at how the intervention could influence students' perceptions of themselves as scientists. The researcher collected data through surveys, focus group interviews, student artifacts, and fieldnotes. Quantitative data were analyzed through descriptive statistics, and qualitative data was analyzed through the constant comparative method. The three major themes which emerged are representation matters, humanization of scientists, and you don't have to be a scientist to enjoy science. Quantitative results suggested the intervention resulted in a less stereotypical perspective on scientists and STEM careers. The researcher displayed findings through poetic transcriptions and graphs.

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"I feel like if I wanted to, I could do what she does."

We had just finished talking about Farah Alibay, a National Aeronautics and Space Administration (NASA) women engineer of color. This was the second modern scientists we had discussed in class and already Dakota (all names have been replaced with pseudonyms) had changed how she viewed engineering as a career. The previous week we talked about Lonnie Johnson, a Black man who worked as a NASA engineer. Dakota at that time said she did not want to be an engineer, but after talking about Alibay she wrote she may be interested in engineering because seeing Alibay "gives me the confidence that I could do the same job." When I approached Dakota and asked her to explain how she felt talking about Alibay compared to talking about Johnson she laughed; she hadn't even realized her opinions about engineering were already changing. Dakota just said "because she was a woman" the career felt more interesting and attainable.

As part of my Master of Education program, I spent one year in a clinical teaching placement. Through my time within my clinical teaching placement, I have learned some state standards get less class time than others. In my experience, standards on educating students about diverse scientists and careers are often ones which teachers spend less time addressing. Through my coursework I have learned the importance of representation within the classroom. Both myself and my cooperating teacher recognized that as White females we could not be that representation for some of our students. I wanted to take a deeper look into how placing intentional focus on these standards, including providing representation that more closely aligned with the demographics of the classroom, could enhance students' understanding of who scientists are and the students' own perceptions of their identity as a scientist.

Purpose

Students need a mirror in which they see themselves in the curriculum (Gay, 2018). However, students who fall into an underrepresented population in the Science, Technology, Engineering, and Mathematics (STEM) fields have expressed they do not experience the vital representation of diverse scientists within their education (Aschbacher et al., 2009; Coleman, 2020). The implementation of intentionally providing examples of diverse scientists could help students develop a scientist identity and pursue a career in STEM (Coleman, 2020); however, little research has been done on the effects of such interventions. The purpose of this study was to identify how diverse representation of scientists in a high school astronomy class impacts students' understanding of who and what a scientist is and how that representation influences students' perceptions of themselves as scientists. My research aimed to answer the following questions:

Quantitative: To what extent does representation of diverse scientists in a high school astronomy class impact students' understanding of who and what a scientist is?

Qualitative: In what ways does representation of diverse scientists in a high school astronomy class influence students' perceptions of themselves as scientists?

This action research study took place during my year-long clinical teaching placement as part of my graduate studies. I was placed in a West Texas town with a population of around 124,000 people. My placement was in Andromeda Independent School District at Cygnus High School, one of three high schools in the district. The school serves around 1,800 students and has roughly the following racial and ethnic demographics: 14% Black, 39% Hispanic, 38% White,

<1% American Indian, 3% Asian, <1% Pacific Islander, and 6% two or more races. At Cygnus approximately 14% of students are in a special education program, 6% of students are identified as limited English proficiency, 7% of students are gifted and talented, and 61% of students are economically disadvantaged.

Literature Review

Science is a well-established part of the secondary education curriculum. Most everyone has taken a science course within their K-12 education, but not everyone goes on to pursue a career in science. Increasing the diversity of our STEM workforce is not only a matter of equity, it is a necessity of the United States of America to remain a global power and fill the expanding STEM careers (Hutton, 2019). Our current STEM workforce is severely lacking in minority populations and women (Hutton, 2019). While the underrepresentation of minorities within STEM careers cannot be attributed to one sociocultural factor, community has been identified as a major influence for minority groups' choice to pursue a job within the STEM field (Haun-Frank, 2011; Hutton, 2019). The STEM field has a need for diversity, but in order to improve the diversity of these careers one component students may need is to see more diverse scientists.

One reason why community may be a key to increasing diversity within STEM lies in the concept of the science identity. The science identity is closely tied with masculinity, meaning qualities used to describe scientists, like being logical or dominant, are also stereotypes typically ascribed to men (Rosa, 2018). This identity leaves minority populations, who have many complex intersections to their identity that do not necessarily align with this masculinity, feeling unwelcome (Rosa, 2018). The masculinities, behaviors societally ascribed to men, found within the science identity strongly align with prominent stereotypes of scientists (Rosa, 2018). Ferguson and Lezotte (2020) did a meta-analysis of the popular 1995 *Draw-A-Scientist Checklist*

(DAST-C) (Finson et al., 1995). The draw a scientist study is a study where students are asked to draw a picture of a scientist and researchers look for recurring stereotypes in the image, like gender, clothing, location, and ethnicity. The data indicated the stereotype of an old white man wearing a lab coat and working inside was still the dominant perception of scientists among students (Ferguson & Lezotte, 2020).

Students grow their personal and academic identities simultaneously (Gay, 2018). Minority students do not see role models from similar backgrounds in STEM careers and are not represented within the scientist identity (Coleman, 2020). Gay (2018) explained school curriculum and materials are missing positive depictions of minority students across disciplines; minority students recognize this and have expressed desire for more representation in their lives and studies (Aschbacher et al., 2009; Coleman, 2020). One cause for students' loss of interest in STEM was a lack of relationship with the identity of a scientist that has been reinforced in schools (Coleman, 2020). Gay (2018) suggested to go beyond the provided classroom textbooks in order to provide representation that corresponds with the demographics of the classroom and help develop both the students' individual and academic identities.

Many studies have been conducted to try and understand what students' perceptions are of themselves as scientists and their interests in pursuing a career in STEM (Aschbacher et al., 2009; Coleman, 2020; Haun-Frank, 2011; Martin & Fisher-Ari, 2021; Pugh et al., 2009). One study found that Black and Latinx students who were initially interested in Science, Engineering, and Medicine (SEM) careers their sophomore year of high school chose a different career path by their senior year of high school more often than White and Asian students (Aschbacher et al., 2009). Martin and Fisher-Ari (2021) investigated high school students' perceptions of representation in STEM through interviews following a three-week STEM summer program and found students recognized stereotypical depictions of race and gender in STEM.

A great deal of research centers on understanding the realities of why the STEM field is not growing in diversity, but little research has been conducted on what happens if educators implement more diverse representation of scientists into their class instruction. Pugh et al. (2010) researched transformative experiences, or instances when students actively used what was learned in class to experience the world in a new and meaningful way, within a high school biology classroom, and results pointed towards an increase in transformative experiences for students who reported some association with the science identity. An intervention of implementing more representation of scientists who break the stereotype could increase high school students' connection to the science identity, resulting in students experiencing more transformative experiences as described by Pugh et al. (2010), and improve minority participation in STEM careers. My research project will fill a gap in the current research on students' perceptions of themselves as scientists. Specifically, my research will address one of the many barriers discouraging minorities from pursuing careers in STEM, the absence of diverse representation. My research aims to enhance students' knowledge of the scientist identity and see how the diverse instruction affects students' initial perceptions of themselves as scientists, if at all.

Methods

This action research study took place in two class periods of astronomy composed of juniors and seniors in high school. Data collection methods included pre- and post-surveys, student artifacts (bell ringers), focus group interviews, and fieldnotes. Qualitative data were analyzed using the constant comparative method (Hubbard & Power, 2003). Codes were created in levels (Tracy, 2013). All quantitative data were analyzed using descriptive statistics (Hendricks, 2017).

Participant Selection

Participants were selected from two class periods of astronomy, one with 28 students and the other with 29 total students. These class periods were selected based on their unique composition of student demographics and academic interests observed prior to the start of the study. A parent information letter and parent consent form were sent home with every student and all students with parent permission completed an assent form at school. Data were collected on the 18 total students, 10 from second period and eight from sixth period, who received parent consent and chose to assent to participate in the study. Of the students who participated, six students self-identified as male, nine self-identified as female, one identified as other, and two preferred not to disclose. The self-identified demographic breakdown of the students who participated are as follows: 44.4% self-identify as White, 11.1% as Asian, 16.7% as Latinx, and 27.8% as Interracial. One focus group from each of the two classes consisting of three to six participants were selected using purposive sampling based on pre-survey responses (Patton, 1990).

Data Collection

This mixed-methods study took place over the course of four weeks. Instructional strategies and activities were introduced to all astronomy students in order to teach about modern diverse scientists and careers. The teachers were intentional with inclusive language within regular class instruction and once to twice a week students received direct instruction over a minority scientist in STEM, their career, and their contributions to astronomy. This instruction occurred at the beginning of class (in the form of a bell ringer or getting started activity).

Two paper surveys, one pre-survey and one post-survey, were conducted at the start and end of the intervention with all participating astronomy classes (see Appendix A). Students were deidentified on the survey through a pseudonym. The survey contained 14 questions total. The first two questions were demographic questions about the students’ gender and their race/ethnicity. Twelve questions were Likert scale questions on scientist stereotypes, student interests in pursuing a STEM career, and to what extent students feel represented in STEM fields.

All students completed reflection questions over the bell ringer activities, but only the assenting students with a signed FERPA consent form in the two selected classes were considered when the bell ringer responses were analyzed. Reflection questions remained constant each week in order to reflect on any changes in response with varying scientists. The bell ringer centered around the students connecting themselves and their background and interests to the scientist talked about in class (see Appendix B). One the final week students answered an additional reflection question on the back of their bell ringer.

Throughout the intervention period headnotes were taken over class discussions in the participating astronomy classes (Hendricks, 2017). During headnotes the observer records key words or phrases heard during the observation, and following the observation the observer sits down to fill in the details of all events that occurred (Hendricks, 2017). The headnotes included anything a student or the class said about the intervention, observations on student behavior that occurred during the intervention, and any other notable moments which related to the purpose of my research.

One focus group of assenting students from each of the two class periods selected met twice during the intervention period. Both focus groups met once at the beginning and once at the end of the intervention for 15 to 20 minutes. These focus groups consisted of six students per group, purposively sampled with one to two students scoring on the high, more diverse end of the pre-survey, one to two students scoring in the middle, and one to two students scoring on the low, less diverse end of the survey (Patton, 1990). All focus group interviews were audio recorded, transcribed, and checked for accuracy.

Data Analysis

Descriptive statistics were used to analyze the Likert scale pre-survey and post-survey questions (Hendricks, 2017). The Likert scale questions were divided into three categories, science stereotype questions, student perception questions, and total survey response. Raw scores for each category of the pre- and post-surveys were calculated for each student and averaged for each class period. Raw scores for the science stereotypes were divided into three levels which corresponded with either a stereotypical scientist, average, or non-stereotypical scientist. Scores for student perception questions were also divided into three levels corresponding with either a low, medium or high perception of self. The total score corresponded to low, medium, or high overall opinions of science. The class average for the pre- and post-survey were added to a double bar graph for each class period. Then the data were disaggregated by gender (men or non-men identifying), and a percent change from pre- and post-survey were calculated and added to a bar graph. The same analysis was done a second time, but this time the data were disaggregated by white students or students of color in order to note differences in effect of the intervention.

Qualitative coding using the constant comparative method was used on the class observations, student bell ringers, and focus group transcriptions for recurring themes (Hubbard & Power, 2003). The first 20% of the data was coded to create level 1 codes directly from the data (Tracy, 2013). Level 1 codes are codes which describe the content of the qualitative data collected. I generated 20 level 1 codes which I then used to code the remaining 80% of the data. Level 2 codes are created by finding the common themes in level 1 codes. The 20 level 1 codes were synthesized to create three level 2 codes which resonated with the overall theme of the level 1 codes (Tracy, 2013). I kept a running index of my codes in order to organize my level 2 codes throughout the analysis process (Hubbard & Power, 2003). For each of my level 2 codes I used memos to help me reflect deeper on the meaning of my data and codes (Tracy, 2013). I created a codebook (see Appendix C) to organize my level 1 and level 2 codes and provide a definition and example for each code (Tracy, 2013). Finally, poetic transcriptions were created for three emerging themes from the coded data (Glesne, 1997). Throughout the poetic transcription process, member checking was used in order to ensure final transcriptions accurately reflected the words and ideas of those participating in the study (Erlandson et al., 1993).

Findings

Analysis of quantitative findings found that talking about specific scientists and careers at least once a week increased most students' perceptions of themselves as scientists and resulted in an overall less stereotypical understanding of scientists and STEM careers. Qualitative analysis unveiled the following three major themes: representation matters, humanization of scientists, and you don’t have to be a scientist to enjoy science. To present my quantitative findings I used bar graphs. Poetic transcriptions were created using participants' thoughts during the focus groups to represent each of the major qualitative themes (Glesne, 1997).

Effects of Diverse Representation on Students’ Understandings of Scientists

Students could score a total of 48 points on the survey and a minimum of 12 points. In the subcategories of students’ view of scientists and students’ perception of self, there was a minimum of six possible points and a maximum of 24 points. Scoring between 19 to 24 points in a subcategory was classified as a high perception or non-stereotypical view for either subcategory, and scoring between 37 to 48 points was considered to be an overall high opinion of scientists. Between 12 to 18 points in a subcategory or 24 to 36 points total was the cut off for the medium perception group. No participants scored in the low section of any category.

Prior to the start of the intervention, 13 out of 18 participants fell into the medium overall opinion of scientists category (see Appendix D). Interestingly, every participant from sixth period started in this category while half of the students in second period started in the high overall opinion category. I selected these two class periods because of the very different academic backgrounds of the students. Second period had not only more White participants, but also more of the participants were students in advanced placement science courses considering STEM careers. I expected to see a difference in pre-survey scores between the two class periods, but I did not know to what extent the intervention would help either class period.

By the end of the intervention, sixth period's class average for post-survey scores not only increased enough to be considered a high overall opinion, but it was also almost equal to the class average of second period. While both periods increased and moved up a category, the students in sixth period increased almost three points more, as seen in Figure 1 and Figure 2! Individual students' raw scores increased so much that students moved up to a high overall opinion. By the end of the study, 13 students had a high overall opinion, nine of which did not start off in that category. Out of the 18 participants, one student, Liam, did score one and a half points lower on their post survey, moving him from a high overall opinion to a medium overall opinion. While this cannot be ignored in my findings, it is worth mentioning that although his survey score decreased, his bell ringer and focus group responses suggest that the intervention was overall still a positive and eye-opening experience for him.

Figure 1

Average Score Second Period Pre-Survey and Second Period Post-Survey

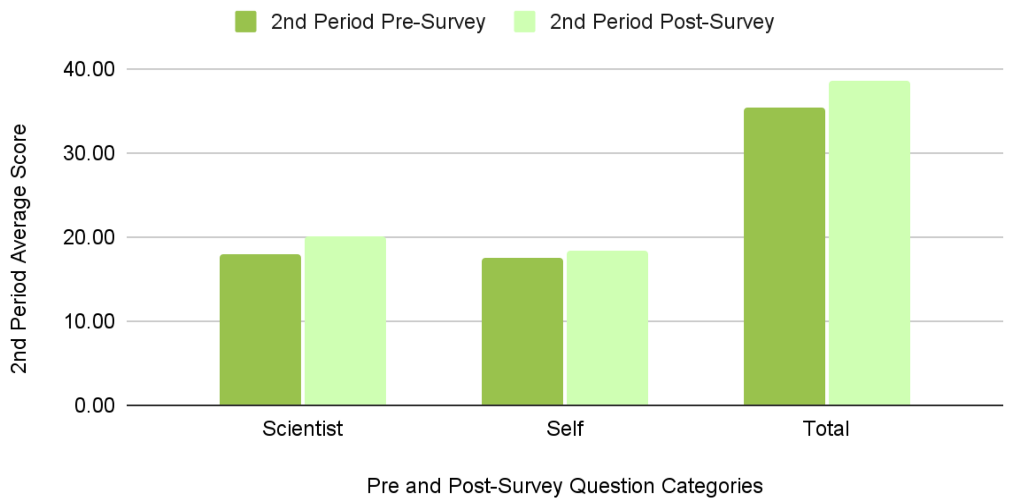
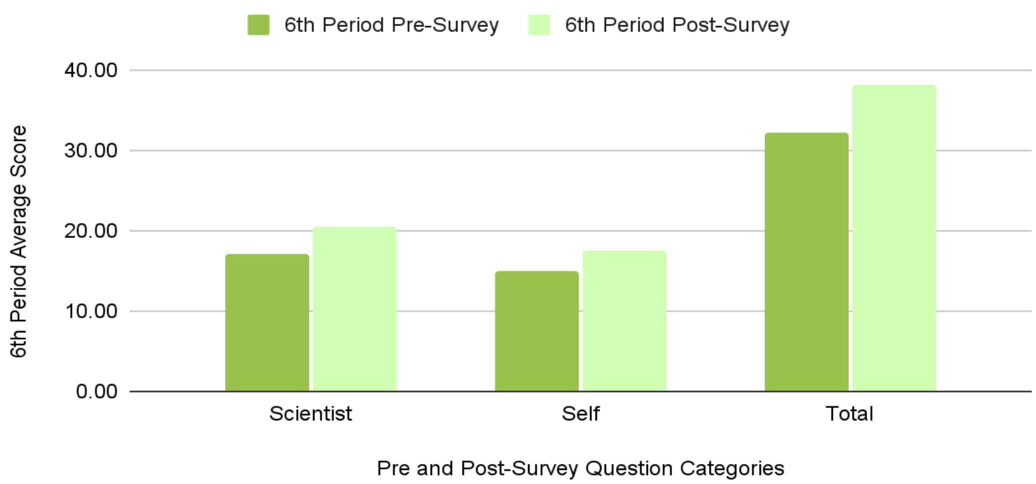


Figure 2

Average Score Sixth Period Pre-Survey and Sixth Period Post-Survey



When disaggregating the data by gender and race/ethnic identity I found something very encouraging. There was a positive percent change for all groups of students, meaning all students finished the intervention with a more positive perception of themselves as scientists and a less stereotypical view of the STEM field. However, non-men identifying students and students of color had a greater percent change than their peers who fell into a category which is considered a majority in STEM as seen in Figure 3 and Figure 4.

Figure 3

Comparison of Percent Change from Pre to Post-Survey for White and Non-White Students

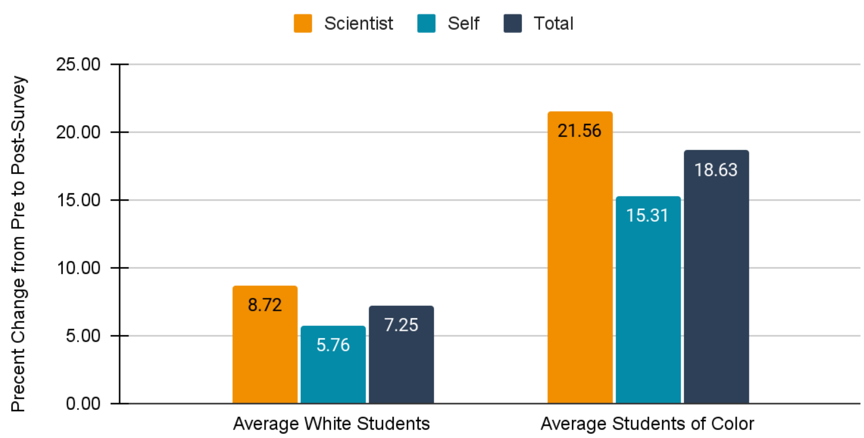
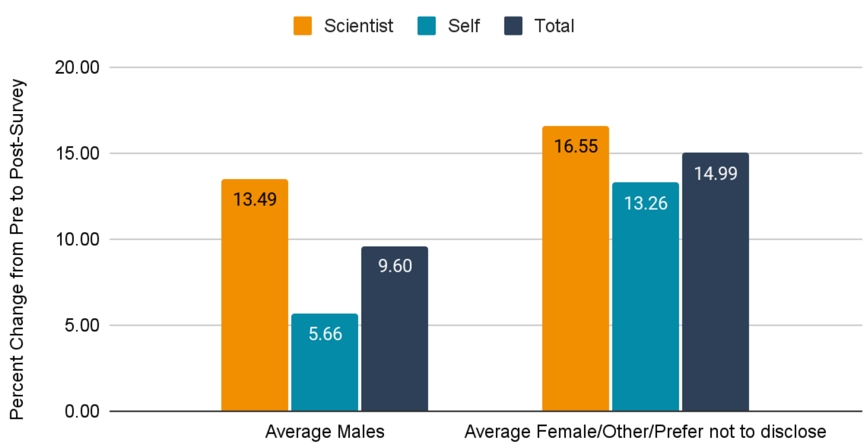


Figure 4

Comparison of Percent Change from Pre to Post-Survey for Men and Non-Men Students



Representation Matters

<u>Stop Making Excuses</u>

It’s just one set straight picture;
a middle-aged white man.
Bill Nye the Science Guy!
Chemicals, test tubes, hot plates

a lab coat, and they have the pens in the pocket
Just somebody a little deranged.

A lot of publicized scientists aren’t very diverse.
There’s inequality and
instead of fixing it, we’re making up excuses on why it’s there.
It’s just more of teachers just doing what the book says.
There’s not enough diversity.
If you could see yourself more represented in a field, you would want to pursue it more.

I really had no idea
anybody can be a scientist,
until you started this research.

It’s more inclusive.
There were a lot of people of color.
It’s just, I don't know, eye opening
someone who looks like me can do great things.

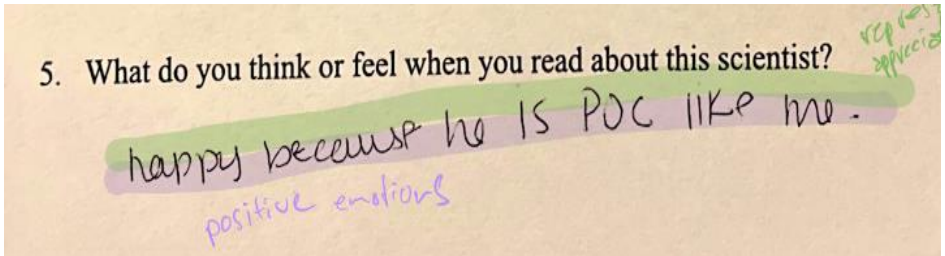
From my first focus groups the students made it clear they never had a teacher talk to them about scientists you do not find in the textbooks. Of course, they had heard of Charles Darwin and Albert Einstein, but no science teacher had taken the time to tell the students about scientists who are still working today, especially about scientists who are not white men. The diverse representation especially resonated with Dakota, who talked about how it had never really been “brought to [her] attention that [the STEM field] has people who are Black, Hispanic, Asian women” who are “doing huge things.” The first scientist of color any of these students learned about was Lonnie Johnson in their astronomy course filled with juniors and seniors, even though the Texas Essential Knowledge and Skills (TEKS) say students should be learning about diverse scientists and STEM careers in each science class. The poetic transcription, created from the words of multiple participants in each of my focus groups, represents the change I witnessed in the participants throughout the study. The students started with a very stereotypical view of scientists, and they knew it. Throughout the research students recognized diverse scientists are not talked about enough, but they also had never been taught about scientists who broke the stereotype. By the end of my study, much like the end of the poem, the students recognized there is no one disposition to describe a scientist.

Representation matters was the first major theme to arise in my analysis. This theme was present any time students talked about scientists not fitting the stereotype of a White man in a lab coat. It also included anytime a student felt they could be a scientist because the scientist reflected them. This finding was important because it completely made sense with what my literature review suggested. Students who were considered a minority in STEM (not men and not White), had a hard time seeing themselves as scientists until they were shown scientists who looked like them. Laila appreciated learning about diverse scientists because it helped her see “that there’s people like [her].” As I worked through the intervention with my students and they received the representation they had been missing in previous science classes, many students began to view themselves more positively as a scientist.

As I read the students’ responses to each scientist and talked with students in focus groups, it was evident that the representation mattered and not just to students of color or students who were not men. Dakota, whom I mentioned at the beginning of this paper, expressed how excited she was to see people of color like her each week (see Figure 5). Zoe, a student in second period, had a similar experience except they expressed how happy it made them to see a woman working as a scientist. I was surprised that some of the White men in my study also expressed appreciation of diverse scientists in class. Robert, a White man, expressed during our final focus group that representation had never been a struggle for him, so he found the research “eye-opening” and expressed gratitude.

Figure 5

Dakota’s Bell Ringer Reflection on Lonnie Johnson



Humanization of Scientists

The Duality of Man

It doesn't seem human.
It's more of their work and not who they are.
They're kind of hidden in a way.
It doesn't really go in depth of who you are.
We're going to care more about the rover that died than the person that actually named them.
It's hard to relate yourself back to science.
I forgot her name.
It's not really human.

That's what being a scientist is all about.

Being a scientist is researching the known and also the unknown.
Science is everywhere;
to contemplate the layers and complexity we do not see at a surface.
The duality of man.
I could see myself-
Just being here has changed my viewpoint of science because,
it's real.

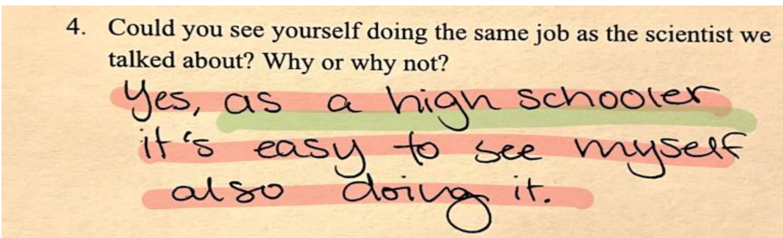
That's what being a scientist is all about.

While my literature review suggested I would find the theme of representation mattering to students, I did not expect the theme I am about to describe. Humanization of scientists revealed itself to me, and my students, slowly. It wasn't until the end of my analysis that the level 2 code jumped out at me and made the findings make sense. The poem above, also created from multiple participants words during the pre- and post-intervention focus groups, demonstrates how the intervention taught students scientists are people, too. That sounds obvious, but until this study the only scientists the participants knew about were those who ended up in textbooks for their work. The students were never taught about all of the struggles that scientists go through before finding something great enough to be in a textbook. Students thought about scientists as storybook characters or robots instead of a viable career option. At the start of the poem, much like at the start of the intervention, the science was real, but the people behind it were a mystery. This left the students feeling removed from science. Robert expressed that “it’s hard to see yourself doing anything with [science], because it doesn’t seem human in a way.” Over the course of the intervention, he felt that his “viewpoint of science” had changed to see it as more “real.” As we continued to talk each week about the scientists and their lives, the students began to realize scientists are not much different than them. If scientists are just like the students, then the students begin to see themselves as scientists.

Looking back, a major point where students began to realize scientists are like them is when we talked about Matteo Kimura, a high school student who works on citizen scientist projects for NASA. The participants saw that someone their age, with no degree, and very little resources can do work as a scientist. Liam, the one student who decreased on his survey score, explained that after learning about Kimura’s work as a citizen scientist he could see himself doing the same thing (see Figure 6). Representation is important for those considered a minority in STEM, but in order for students to see themselves as scientists, or consider STEM careers, they also need to know scientists are people too.

Figure 6

Liam’s Bell Ringer Reflection on Matteo Kimura



You Don't Have to Be a Scientist to Enjoy Science

I Just Don't See Myself Doing That

If you don't have motivation, then there's really no reason for you to be going into that field.
I don't see myself being able to be a scientist.
I mean I find it really interesting.
That's what you're passionate about?
That is so cool!
She seems to really love doing that.

I just don't see myself doing that.

This is a science class I actually like.
Y'all are funny;
it makes the student excited as well.
I feel like students could be scientists;
if that is something they are aiming for
This can be fun.

I just don't see myself doing that.

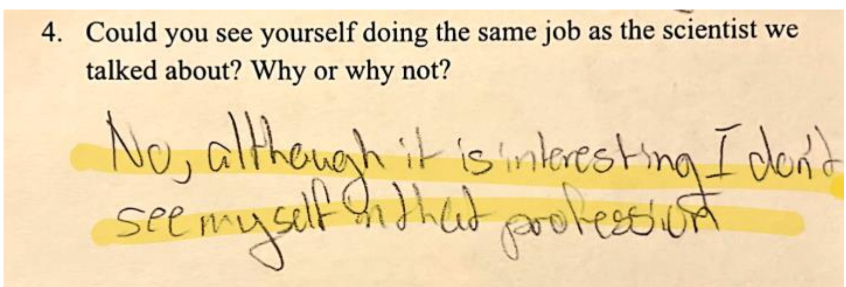
As much as science teachers hope to inspire their students to go on to college and pursue a career in STEM, we recognize that it is not the path for everyone. A more attainable goal for science teachers is to make science classes an enjoyable space where every student knows they can go on to work in STEM, if that is their passion. That is exactly what the final major theme of my research represents. The poem above was created from the words of multiple participants during the four focus groups conducted throughout the intervention period. The poem represents how students can enjoy science classes and appreciate the dedication it takes to work in STEM without desiring the same career for themselves.

While analyzing the bell ringer reflections each week, some students came up with a lot of kind ways to tell me they are not interested in being a scientist. Henry expressed interest in being a musician since the beginning of my research because that is his passion. However, each week he still enjoyed hearing about different people who work in science (see Figure 7).

Stephanie also found the intervention exciting while still sharing they do not want to work in STEM. During the final focus group Stephanie said, "I just don't think I could see myself… just doing experiments… I find it really interesting and amazing how people can accomplish their career. I just don't see myself doing that." To those students, I continued to tell them each week that it is okay to not go to school for STEM, but that I hoped they would find a passion in their lives like these scientists have found for themselves. While my research did not suddenly make every participant view themselves as a scientist, it did lead the students to realize science class can be fun and interesting.

Figure 7

Henry's Bell Ringer Reflection for Aomawa Shields



Implications for Teachers

The purpose of this study was to identify how diverse representation of scientists in a high school astronomy class impacts students' understanding of who and what a scientist is and how that representation influences students' perceptions of themselves as scientists. Each week, 10 to 15 minutes of class time was dedicated to talking about a minority in STEM, pictured on a PowerPoint slide, and their career followed by a bell ringer reflection about the scientist and their job. Based on the change in participants' pre- and post-survey scores, I can conclude this intervention resulted in nearly all participants expanding their understanding of scientists and STEM careers to a less stereotypical description, including how they themselves are included in the definition of a scientist. From my qualitative data I discovered that including representation that deviates from the stereotypical scientist and that humanizes scientists improved students’ perceptions of themselves as scientists. Although not all students’ perceptions of themselves as scientists shifted, my data also suggest even those who still do not believe they are scientists now have a greater appreciation and interest in science as a discipline.

During the intervention period, I began to consider in what ways the intervention could be improved. It would be interesting to look at the most effective way to add diverse scientists into a class. During my research, I found students responded well to video interviews of the scientists we were discussing. Future studies might explore in what ways guest speakers would allow for students to further connect with scientists and feel they have a STEM mentor in their life. I also chose a very direct method to teach students about each scientist by dedicating class time to solely discuss the scientist for the day. Another area for future study is how taking a more subtle, or inquiry approach, in which students play an active role in discovering the diversity of science could affect the outcome.

While the data supported that covering diverse scientists and careers was worthwhile, the study was limited. Out of the 57 students between the two class periods, only 18 received consent to participate in data collection. This means I could not reliably determine the significance of the change in pre- and post-survey scores. All of the students who participated expressed enjoying the intervention, but it is certainly possible (like with any lesson) that there are students who did not feel the same way as their peers. In spite of these limitations, I will continue to include bell ringers on diverse scientists within my future classes because this study demonstrated that doing so helps students develop their scientist identity.

Teachers who want to assist students in developing a scientist identity, deepening their understanding of STEM careers and the diversity in STEM, and increasing their appreciation of science overall should first take the time in their classroom to talk to their students about scientists who may not be found in a textbook and who can serve as a mirror for students to see themselves in the STEM field. When selecting what scientists to discuss in class, educators must consider the demographics of their classroom, student interests, and students’ understanding of scientists and STEM careers. Through this study, I found bell ringers to be one flexible and efficient way to discuss scientists that fit the needs for representation in my classroom. Teachers, especially those who are just starting to include education on scientists outside of the stereotype, should consider using bell ringers as an easy starting place that can be built upon throughout the school year. When teachers intentionally highlight the multifaceted aspects of the science identity, students will begin to develop a sense of belonging within the STEM community.

References

Aschbacher, P. R., Li, E., & Roth, E. J. (2009). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching*, *47*(5), 564–582. https://doi.org/10.1002/tea.20353

Coleman, A. (2020). D-STEM equity model: Diversifying the STEM education to career pathway. *Athens Journal of Education*, *7*(3), 273–296. https://doi.org/10.30958/aje.7-3-3

Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing naturalistic inquiry: A guide to methods*. SAGE Publications, Inc.

Ferguson, S. L., & Lezotte, S. M. (2020). Exploring the state of science stereotypes: Systematic review and meta-analysis of the Draw-A-Scientist Checklist. *School Science and Mathematics*, *120*(1), 55–65. https://doi.org/DOI: 10.1111/ssm.12382

Finson, K. D., Beaver, J. B., & Cramond, B. L. (1995). Development and field test of a checklist for the Draw-A-Scientist Test. *School Science and Mathematics*, 95(4), 195–205. https://doi. org/10.1111/j.1949-8594.1995.tb15762.x

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice*. Teachers College Press.

Glesne, C. (1997). That rare feeling: Re-presenting through poetic transcription. *Qualitative Inquiry*, *3*(2), 202–221.

Haun-Frank, J. (2011). Narratives of identity in everyday spaces: An examination of African American students' science career trajectories. *Science Education International*, *22*(4), 239–254.

Hendricks, C. (2017). *Improving schools through action research: A reflective practice approach* (4th ed.). Pearson.

Hubbard, R. S., & Power, B. M. (2003). *The art of classroom inquiry: A handbook for teacher-researchers* (Rev ed.). Heinemann.

Hutton, C. (2019). Using role models to increase diversity in STEM: The American workforce needs every capable STEM worker to keep America in a global leadership position. *Technology and Engineering Teacher*, *79*(3), 16–19.

Martin, A. E., & Fisher-Ari, T. R. (2021). "If we don't have diversity, there's no future to see": High-school students' perceptions of race and gender representation in STEM. *Science Education*, *105*(6), 1076–1099. https://doi.org/10.1002/sce.21677

Patton, M. (1990). *Qualitative evaluation and research methods* (2nd ed.). Sage.

Pugh, K. J., Linnenbrink-Garcia, L., Koskey, K. L. K., Stewart, V. C., & Manzey, C. (2010). Motivation, learning, and transformative experience: A study of deep engagement in science. *Science Education*, *94*(1), 1–28. https://doi.org/10.1002/sce.20344

Rosa, K. (2018). Science identity possibilities: A look into Blackness, masculinities, and economic power relations. *Cultural Studies of Science Education*, *13*(4), 1005–1013. https://doi.org/10.1007/s11422-018-9859-z

Tracy, S. J. (2013). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. Wiley-Blackwell.

Appendix A

Survey on Scientists and Science Careers

Circle the answer to each question about how you identify. There are no right or wrong answers.

1. What is your gender identity?

   Male Female Other Prefer not to disclose

2. What is your race/ethnicity?

   a. White
   b. Black
   c. Asian
   d. Native Hawaiian/Pacific Islander
   e. Native American/Native Alaskan
   f. Latinx
   g. Interracial______________________
   h. Other______________________
   i. Prefer not to disclose

Circle the answer to each question that you feel best applies to your experiences with scientists and science careers. This is about what you see or think, so there are no right or wrong answers.

3. Scientists wear lab coats when working.

   Never Occasionally Mostly Always

4. Scientists work in a lab.

   Never Occasionally Mostly Always

5. Scientists have a four (4) year college degree or more.

   Never Occasionally Mostly Always

6. Science is for smart or naturally gifted people.

   Strongly Disagree Disagree Agree Strongly Agree

7. I feel I am good at science

   Strongly Disagree Disagree Agree Strongly Agree

8. Any gender can work as a scientist.

   Strongly Disagree Disagree Agree Strongly Agree

9. I feel my gender is represented in the scientific community.

   Strongly Disagree Disagree Agree Strongly Agree

10. Any race/ethnicity can work as a scientist.

    Strongly Disagree Disagree Agree Strongly Agree

11. I feel my race/ethnicity is represented in the scientific community.

    Strongly Disagree Disagree Agree Strongly Agree

12. If I saw more scientists who looked like me, I would be more likely to consider a science career.

    Strongly Disagree Disagree Agree Strongly Agree

13. I have at least one scientist role model in my life that I can talk to about career options.

    Strongly Disagree Disagree Agree Strongly Agree

14. I am a scientist right now in high school.

    Strongly Disagree Disagree Agree Strongly Agree

Appendix B

Bell Ringer Reflection

Name:________________________________Period:________

1. Have you ever heard of this scientist before today?

2. Have you heard of this scientist's job(s) before today?

3. When we talked about this scientist, what did you find most interesting about the scientist and their job? Why?

4. Could you see yourself doing the same job as the scientist we talked about? Why or why not?

5. What do you think or feel when you read about this scientist?

6. Do you have anything else you would like to share?

Appendix C

Codebook

Code	Level	Definition	Example
Humanization of Scientists	2	Students discuss scientists and science being humanized and driving discoveries.	“Because like we hear about this stuff all the time, ‘Oh, somebody was sent to the moon,’ but we don’t hear about how it happens.”
I can be a scientist	1	Student made a connection to previous science knowledge or felt they could participate in science	“I like creating things also” “I can do that too”
“Duality of man”	1	Students recognized scientists are people too	“Seeing Lonnie Johnson being just a normal guy”
People can learn from failure	1	Students discuss the scientist or themselves persevering through failure	“What you do wrong can be turned into a whole new idea”
“Never stop learning”	1	Students comment on the continuation of learning throughout life/beyond formal schooling	“You can do anything you want at any time”
I’m not sure what I want to do	1	Student expressed not knowing what they would like to in the future or unsure if they would like to participate in the same career as the weekly scientist	“I’ve completely changed my career path”
Representation matters	2	Students appreciate teachers talking about non-stereotypical scientists	“No matter my color or gender because there are other diverse women who are successful scientists.”
Representation of diverse scientists appreciated	1	Student identifies feeling represented by the weekly scientist or appreciating the non-stereotypical scientist	“Happy because he is a POC like me”

Not all scientists are the same	1	Student discusses a characteristic that does not describe the stereotypical scientist	"I don't have to go to school for it"
"Bill Nye" stereotype	1	Student discusses a stereotype of scientists	"Being told to choose between art & science & that they don't interact"
Connection to racial inequities	1	Student identified barriers to people of color entering STEM	"Especially back when segregation still existed"
You don't have to be a scientists to enjoy science	2	Students, although not interested in working as a scientist, enjoyed learning about the scientists and careers.	"No, I think it is interesting but not the exact one I am passionate about."
Science can be an enjoyable career	1	Student identified weekly scientist enjoying their job or student found the career interesting	"Looks to make him happy" "It looks like fun"
"It doesn't peak my interest"	1	Student was not interested in the career or scientist	"My passions don't line up with hers"
Being a scientist takes passion and dedication	1	Students drew attention to the amount of work and passion that goes into being a scientist	"I thought she was very determined"
Positive opinion of weekly scientist	1	Student expressed positive opinions about the weekly scientist's career, accomplishments, or personality	"He is really cool" "I'd love to meet and talk with her"
Intervention left student with positive emotions	1	Students expressed a feeling a positive emotion when discussing the intervention	"Makes me feel awesome" "Very inspired"
Additional Codes			
Thinking of future plans	1	Student made a statement about their future plans	"I want to work for NASA"
I'm not smart enough	1	Student expressed their intelligence as a roadblock to participating in STEM	"No I do not feel I am capable of the complex thought"

I’m not creative enough	1	Student expressed their creativity as a roadblock to participating in STEM	“I don’t feel nearly as creative as him”
Student feeling negative emotions	1	Student expressed a feeling a negative emotion during the intervention	“I’m stressed”
Unknown scientists/career	1	The scientist or career was new to the student	“No”
Known scientists/career	1	Student already knew about the weekly scientist or career	“Yes”

Appendix D

Table of Individual Participants’ Pre- and Post-Survey Total Raw Scores

Pseudonym	Gender	Race/Ethnicity	Pre-Survey Total	Post-Survey Total
Marcus	Male	Latinx	29.00	39.00
Stephanie	Female	Asian	30.00	33.00
Peter	Male	White	42.00	42.00
Anna	Female	White/Mexican	33.50	36.00
Clarissa	Female	White	37.00	38.00
Robert	Male	White	40.00	43.00
Zoe	Prefer not to disclose	White	35.00	39.50
Nicole	Female	Latinx	29.00	38.00
Laila	Female	White	40.00	41.00
Liam	Male	Asian	37.50	36.00
Henry	Male	Latino/Asian	33.00	39.00
Elizabeth	Female	White	36.00	39.00
Trey	Other	White	31.50	37.50
Alex	Prefer not to disclose	White	35.00	38.00
Rachel	Female	White/Mexican	32.00	36.50
Vince	Male	Black/Latinx	32.00	35.00
Karina	Female	Latinx	30.00	38.00
Dakota	Female	Black/Latinx/Native American/Native Alaskan	28.00	42.00