

STEM Professionals and Stereotypes: Broadening Students' Perceptions

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Abstract

Since 1957, educators and social scientists have documented students' stereotypical images of scientists, which persist in other STEM (Science, Technology, Engineering, and Mathematics) professions as well. Despite efforts to depict professionals from various racial groups and genders through media, literature and educational materials, students still often perceive them as white males working in isolation. Adults, including inservice and preservice teachers, who influence students' perceptions, also share these stereotypes. This study uses the Draw a STEM Professional Test (DASP Test) to explore stereotypes among students and teachers. The results indicate the need for strategies to change these perceptions and to present a more diverse and realistic portrayal of STEM professionals. These findings highlight the importance of diversifying how STEM professionals are portrayed in classrooms, literature, and media. Expanding these representations not only broadens students' perceptions of who can succeed in STEM but also plays a critical role in recruiting and retaining talent from underrepresented groups.

Keywords: STEM identity; STEM teacher preparation; draw a scientist; teacher education; STEM diversity

Introduction

Many agencies, organizations, and curriculum developers aim to eliminate students' stereotypes of scientists. However, these efforts have not significantly changed students' perceptions. Evidence suggests that students do not view scientists as role models, often perceiving them as isolated white males in boring positions, affecting their interest in science and STEM careers. This perception relates to students' self-efficacy and locus of control, influencing their educational and career choices in science [1-5]. Fewer students state they would aspire to pursue a career in science as they have a difficult time identifying with these professionals. Further, it was revealed that pre- and inservice teachers possess similar stereotypes, especially those who work with young learners in early childhood and elementary school. Teachers must have an accurate view of scientists and careers as they have the ability to greatly impact their students.

In this century, STEM careers have been frequently depicted in series such as "CSI," "Bones," and "The Big Bang Theory," both expanding the view of STEM workers as well as exacerbating some of the stereotypes. Additionally, movies about science and scientists abound, with films such as "The Theory of Everything" and "Hidden Figures" present diverse contributors to the field. News shows also play a role in shaping perceptions by featuring scientists as experts in their fields, including women meteorologists and other STEM professionals who often provide commentary and analyses.

The study examines the hypothesis that students continue to hold similar stereotypes about STEM professionals as they had about scientists in past studies despite the context of modern media and literature. To examine this hypothesis, author 1

modified Chambers' (1983) [6] Draw a Scientist Test (DAST) by incorporating other STEM professionals and reducing the number of attributes, resulting in the creation of the Draw a STEM Professional Test (DASP Test). Six-hundred thirty-four students aged four through grade five participated, as did 77 preservice and 121 Inservice teachers of students aged four through fifth grade.

Current state of diversity in STEM

The 2023 NSF report, "Diversity and STEM: Women, Minorities, and Persons with Disabilities," underscores the gradual diversification of the U.S. STEM workforce from 2011 to 2021, noting increases in the representation of women and underrepresented minorities. By 2021, women constituted more than half (51%) of the total U.S. population aged 18 to 74 years but only about a third (35%) of those employed in STEM occupations. Additionally, Hispanic workers made up 15% of the STEM workforce, while Asian and Black workers accounted for 10% and 9%, respectively. American Indians and Alaska Natives comprised less than 1% of both the U.S. population and the STEM workforce in 2021. Furthermore, individuals with disabilities represented a notable portion of the STEM workforce; however, they often faced significant challenges, including lower median earnings compared to their non-disabled counterparts (NSF, 2023).

Background

Mead and Metraux (1957) [7] began the work of student perceptions of scientists by surveying 35,000 high school students about their image of a scientist. The student essays revealed the majority perceived scientists as middle-aged or elderly while men in a white coat with glasses in a laboratory setting. Beardslee and O'Dowd (1961) [4] created a seven-point scale to evaluate a questionnaire given to 1,200 male and female college students from various socioeconomic backgrounds, ages, as well as public and private schools. Their findings were

similar to results of Mead and Metraux. Krajcovich and Smith (1982) [8] developed a 48 item, seven-point Likert-scaled inventory called the Image of Science and Scientists Scale. Results over two decades of research utilizing this tool yielded the same stereotypical images of scientists.

Research since Mead and Metraux (1957) [7] has shown that students often view scientists as middle-aged or elderly white men in lab coats. This stereotype persists across various studies [4,8,6]. Chambers' Draw-a-Scientist-Test (DAST) identified common stereotypes and validated them across different ethnic groups [1]. These stereotypes are also prevalent among teachers, particularly those working with younger students [9-11].

Chambers (1983) [6] created the Draw-a-Scientist-Test (DAST) to more accurately ascertain Kindergarten through grade five students' perceptions of scientists. He felt that young students lacked the ability to verbally state or write their thoughts to the degree needed, so his 4,800 elementary student participants drew a scientist on a blank sheet of paper. Chambers identified seven attributes that appeared in these drawings: lab coat, symbols of research (test tubes), symbols of knowledge (books), products of science (rocket), facial hair, eyeglasses, and captions (eureka). He also looked for signs of danger, mythical images, or secrecy. Findings revealed similar results to the study of Mead and Metraux. Students' naive perceptions of scientists were thought to come from exposure to media, namely cultural models during exposure to movies, television, and comic books (1983).

Finson (2001) [1] validated the DAST for ethnic groups outside the one for which the DAST was validated, middle class Caucasians. He concluded there was no significant difference among the various groups; all held the same stereotypes of scientists.

This same stereotypical image of scientists was prevalent among inservice teachers [9,10] and preservice teachers [11]. A higher percentage of early childhood and elementary teacher candidates held these beliefs compared to their peers at the middle and high school levels and did not recognize there was a problem with their stereotypes [10].

STEM professionals stereotypes

The United States, like many other nations, relies on STEM positions for economic growth [12]. Despite efforts to recruit and retain students in STEM fields, stereotypes persist [13,14]. The DASP Test was used to examine these stereotypes among students and teachers. The test revealed that students and teachers often depict STEM professionals as male, Caucasian, middle-aged or elderly, working indoors, and in isolation.

Material and Methods

The study involved 634 students aged four to grade five, and 198 preservice and inservice teachers. Participants were asked to draw STEM professionals, and their drawings were analyzed for specific indicators, such as gender, race, and working conditions. This study was approved by the Saginaw Valley State University IRB Committee (approval no. 1697496-1).

The term STEM is prevalent and in use within United States schools today, though is enough being done to recruit and retain student talent in these areas? Using the same premise as Chamber's (1983) [6] Draw a Scientist Test (DAST), this author replicated the steps to include technologist, engineer, and

mathematician for the Draw a STEM Professional Test (DASP Test) with the hypothesis of young students' perceptions of STEM professionals as similar to that of scientists. As research suggests that images are formed by the time a child reaches second grade and becomes more permanent as he/she ages [15], students aged four to fifth grade were chosen for this study. The DAST-C was modified to include the following five main and six secondary DASP Test indicators.

DASP Test Main Indicators

- (1) Male gender
- (2) Caucasian
- (3) Middle-aged or elderly
- (4) Working indoors
- (5) Working in isolation

DASP Test Secondary Indicators

- (1) Symbols of research (instruments, equipment)
- (2) Symbols of knowledge (books, clipboards)
- (3) Technology (computers)
- (4) Relevant captions (formulae, taxonomic classification)
- (5) Indications of secrecy (signs or warnings that read Private, Keep Out, Do Not Enter, Go Away, Top Secret)
- (6) Indications of danger

These data allow us to examine two research questions.

- How does the perception of STEM professionals compare amongst students, inservice and preservice teachers?
- How do the perceptions of scientists, technologists, engineers and mathematicians compare among students, preservice teachers and inservice teachers.

Draw a STEM professional (DASP) test

Six-hundred thirty-four students from a mid-western state aged four years to fifth grade folded a blank, eight-inch by 11-inch paper into fourths and unfolded it to draw a STEM professional within each quadrant. While holding the same, folded blank paper, the classroom teacher pointed to the top left of the paper and prompted the students to simply draw a scientist. This was repeated to include technologists, engineers, and mathematicians within the other three rectangles.

The school settings included rural, urban, and suburban. Thirteen ethnicities were identified, and approximately 59% of the students were Caucasian. Seventy of these participants who were aged four, five, and six were asked three questions about their drawings to gain a better understanding of their thinking, "What does a scientist look like, where is the scientist, and What is the scientist doing?"

The DASP Test was also administered to seventy-seven preservice teachers majoring in early childhood and elementary education and one-hundred twenty-one early childhood and elementary teachers of students from four-year-old preschool classrooms to grade five. Each student, preservice and inservice teacher's DASP Test was evaluated for main and secondary indicators.

Results

Table 1 shows DASP Test main and secondary indicators in the first column. The second column shows the percentage of students aged four to fifth grade whose drawing included the indicator stated in the areas of S science; T technology; E engineering; and M mathematics. Columns three and four provide percentages of indicators for pre and inservice teachers.

Table 1: Data from Drawings.

	DASP Test Main and Secondary Indicators	Students aged 4 to fifth grade N=634	Preservice Teachers N=77	Inservice Teachers N=121
Main Indicators	(1) Male gender	S – 84%	S – 84%	S – 79%
		T - 89%	T - 85%	T - 80%
		E – 82%	E - 85%	E - 84%
		M - 81%	M - 81%	M - 80%
	(2) Caucasian	S – 86%	S – 86%	S – 82%
		T - 89%	T - 88%	T - 80%
		E - 84%	E - 85%	E – 86%
		M - 84%	M -83%	M -72%
	(3) Middle-aged or elderly	S – 87%	S – 86%	S – 83%
		T – 88%	T - 86%	T- 80%
		E – 88%	E – 87%	E – 85%
		M - 87%	M - 84%	M - 73%
(4) Working indoors	S – 92%	S – 86%	S – 76%	
	T – 98%	T - 88%	T - 82%	
	E – 72%	E – 88%	E - 87%	
	M - 96%	M - 92%	M - 90%	
(5) Working in isolation	S – 88%	S – 86%	S – 85%	
	T - 92%	T - 90%	T – 76%	
	E - 90%	E – 88%	E – 87%	
	M - 79%	M - 73%	M - 48%	
Secondary Indicators	(1) Symbols of research (instruments, equipment)	S - 79%	S – 77%	S – 72%
		T - 33%	T – 28%	T – 20%
		E - 26%	E – 38%	E – 46%
		M - 81%	M - 92%	M - 90%
	(2) Symbols of knowledge (books, filing cabinets, clipboards)**	S – 49%	S – 44%	S – 28%
		T - 39%*	T – 13%*	T – 5%*
		E - 41%	E – 22%	E - 18%
		M - 31%	M - 42%	M - 40%
	(3) Technology (computers, smart podium)*	S – 2%	S – 7%	S – 18%
		T - 92%	T – 97%	T – 92%
		E - 22%	E – 48%	E – 44%
		M - 28%	M – 49%	M – 38%
	(4) Relevant captions (formulae, taxonomic classification)	S – 6%	S – 21%	S – 17%
		T – 0%	T – 0%	T – 1%
		E – 0%	E – 2%	E – 4%
		M – 18%	M – 11%	M – 14%
	(5) Indications of secrecy (signs or warnings that read “Private,” “Keep Out,” “Do Not Enter,” “Go Away,” “Top Secret”)	S – 9%	S – 4%	S – 2%
		T - 13%	T - 0%	T - 0%
		E - 0%	E – 0%	E – 0%
		M – 1%	M – 0%	M – 0%
	(6) Indications of danger***	S – 38%	S – 35%	S – 29%
		T – 1%	T – 0%	T – 0%
		E – 3%	E – 0%	E – 0%
		M – 0%	M – 0%	M – 0%

S= Scientists, T= Technologist, E= Engineers, and M=Mathematician

*p<0.05, **p<0.01, ***p<0.005

Research Question 1: How does the perception of STEM professionals compare amongst students, inservice and preservice teachers?

The study found that over 80% of drawings depicted STEM professionals as *male*, *Caucasian* and *middle aged or older* with the exception of 72% of inservice teachers’ depiction of math professionals as Caucasian and 73% middle aged or elderly (Table 1). Over 80% worked indoors, with the exception of 4-year olds to 5th graders depiction of 72% engineers and inservice teachers 76% scientists. Over 70% of the professionals were represented working in isolation except for the math

professional as depicted by the inservice teacher (only 48%). Overall, the vast majority of pictures of STEM professionals were Caucasian men, working inside in isolation, aligning with previous studies discussed above. The ANOVA results indicate that there is no significant difference across the participant groups for most of these main indicators. P-values in this category are significantly higher than the typical significance level of 0.05. (Table 2)

When we examined the depiction of the space around the professional (secondary indicators), nearly all categories saw no significant difference across participant groups, with the

exception of *symbols of knowledge* drawings of technology suggesting a moderately significant difference amongst the professionals, which ranged from 5-39%, ($p = 0.0455$) participant groups.

Table 2: ANOVA p -values comparing students, inservice teachers and preservice teachers.

Indicator		Science (p-value)	Technology (p-value)	Engineering (p-value)	Mathematics (p-value)
Main Indicators	Male gender	0.6100	0.6085	0.9285	0.7845
	Caucasian	0.5945	0.6546	0.9148	0.2560
	Middle-aged or elderly	0.4583	0.5060	0.8496	0.2775
	Working indoors	0.0682	0.1390	0.3834	0.5723
	Working in isolation	0.7340	0.1183	0.5231	0.0679
Secondary Indicators	Symbols of research	0.3743	0.3777	0.2874	0.4807
	Symbols of knowledge	0.0834	0.0455*	0.0569	0.5044
	Technology	0.2857	0.8908	0.2095	0.3799
	Relevant captions	0.2681	0.5430	0.5627	0.4906
	Indications of secrecy	0.4453	0.3164	N/A	0.5890
	Indications of danger	0.4677	0.3532	N/A	N/A

* $p < 0.05$

Research Question 2: How do the perceptions of scientists, technologists, engineers and mathematicians compare among students, preservice teachers and inservice teachers?

The study found that across the main indicators of gender (male), race (Caucasian), and age (middle-aged/older), there was no significant difference across the fields with p values much greater than 0.05. Drawings were overwhelmingly male, Caucasian, and middle-aged/older. The main indicators of working environments showed only a moderate significant

difference in *working in isolation*, with mathematicians represented less frequently in this way ($p = 0.0459$).

Secondary indicators uncovered more variation. *Symbols of knowledge* varied greatly across the STEM fields ($p=0.0045$). Technologist drawings (over 90%) were more likely to include drawings with *technology* compared to less than 50% of other representations ($p=0.0489$). Between 29% and 38% of science professional drawings showed *indicators of dangers*, almost unique to this category ($p=0.0069$) (Table 3).

Table 3: ANOVA testing different amongst STEM fields (science, technology, engineering, and mathematics) for each indicator.

DASP Main Indicators	p -value	DASP Secondary Indicators	p -value
(1) Male gender	0.8383	(1) Symbols of research (instruments, equipment)	0.0717
(2) Caucasian	0.2842	(2) Symbols of knowledge	0.0045***
(3) Middle-aged or elderly	0.3181	(3) Technology	0.0489*
(4) Working indoors	0.0758	(4) Relevant captions	0.4538
(5) Working in isolation	0.0459*	(5) Indications of secrecy	0.6127
		(6) Indications of danger***	0.0069**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$

Overall, the perception of the four fields (STEM) was highly correlated across students, preservice and inservice teachers as well as amongst the four fields (Table 4), suggesting the

participants see STEM professionals the same way with slight variation in the work they do and hold the same stereotypes about the professionals themselves.

Table 4: Correlations of Data.

Variables		DASP_Indicators	Science	Technology	Engineering	Math
DASP_Indicators	Pearson Correlation	1	-.844**	-.767**	-.913**	-.881**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	N	33	33	33	33	33
Science	Pearson Correlation	-.844**	1	.615**	.859**	.873**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000
	N	33	33	33	33	33
Technology	Pearson Correlation	-.767**	.615**	1	.885**	.732**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000
	N	33	33	33	33	33
Engineering	Pearson Correlation	-.913**	.859**	.885**	1	.861**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000
	N	33	33	33	33	33
Math	Pearson Correlation	-.881**	.873**	.732**	.861**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	N	33	33	33	33	33

Significant correlations were found between these stereotypes and students' perceptions of STEM professionals. These findings suggest that stereotypes are deeply ingrained and affect students' views of STEM careers, and this perception extends to both pre-service and in-service teachers [16]. The data tables are shared to understand correlations between the groups, indicators, and professional areas. The Pearson correlations

between DASP indicators and STEM responses revealed some significant linear relationships ($p < 0.01$). The DASP indicators in totality showed a strong inverse association with responses in Science, Technology, Engineering, and Math. Although there were differences between groups, they were not statistically significant at the $p > 0.05$ level (Table 5).

Table 5: Means of the average of the students, preservice teachers and inservice teachers from Table 1.

		Science	Technology	Engineering	Math
Male Gender	Mean	82.3333	84.6667	83.6667	80.6667
	N	3	3	3	3
	Std. Deviation	2.88675	4.50925	1.52753	0.57735
Caucasian	Mean	84.6667	85.6667	85.0000	79.6667
	N	3	3	3	3
	Std. Deviation	2.30940	4.93288	1.00000	6.65833
Middle-Aged or Elderly	Mean	85.3333	84.6667	86.6667	81.3333
	N	3	3	3	3
	Std. Deviation	2.08167	4.16333	1.52753	7.37111
Working Indoors	Mean	84.6667	89.3333	82.3333	92.6667
	N	3	3	3	3
	Std. Deviation	8.08290	8.08290	8.96289	3.05505
Working in Isolation	Mean	86.3333	86.0000	88.3333	66.6667
	N	3	3	3	3

	Std. Deviation	1.52753	8.71780	1.52753	16.44182
Symbols of Research	Mean	76.0000	27.0000	36.6667	87.6667
	N	3	3	3	3
	Std. Deviation	3.60555	6.55744	10.06645	5.85947
Symbols of Knowledge	Mean	40.3333	19.0000	27.0000	37.6667
	N	3	3	3	3
	Std. Deviation	10.96966	17.77639	12.28821	5.85947
Technology	Mean	9.0000	93.6667	38.0000	38.3333
	N	3	3	3	3
	Std. Deviation	8.18535	2.88675	14.00000	10.50397
Relevant Captions	Mean	14.6667	0.3333	2.0000	14.3333
	N	3	3	3	3
	Std. Deviation	7.76745	0.57735	2.00000	3.51188
Indications of Secrecy	Mean	5.0000	4.3333	0.0000	0.3333
	N	3	3	3	3
	Std. Deviation	3.60555	7.50555	0.00000	0.57735
Indications of Danger	Mean	34.0000	0.3333	1.0000	0.0000
	N	3	3	3	3
	Std. Deviation	4.58258	0.57735	1.73205	0.00000

Within Table 5, the mean differences are further displayed/broken out by group and then by the specific DASP indicator group giving the mean scores across STEM. Again, differences were not statically significant across groups at the

0.05 level. An Analysis of Variance (ANOVA) was conducted to see if these differences across means were significant. They were not (Table 6).

Table 6: Analysis of Variance (ANOVA).

		Sum of Squares	df	Mean Square	F	Sig.
DASP_Indicators	Between Groups	0.000	2	0.000	0.000	1.000
	Within Groups	330.000	30	11.000		
	Total	330.000	32			
Science	Between Groups	134.606	2	67.303	0.056	0.945
	Within Groups	35871.455	30	1195.715		
	Total	36006.061	32			
Technology	Between Groups	632.909	2	316.455	0.185	0.832
	Within Groups	51255.636	30	1708.521		
	Total	51888.545	32			
Engineering	Between Groups	70.242	2	35.121	0.024	0.976
	Within Groups	43735.818	30	1457.861		
	Total	43806.061	32			
Math	Between Groups	180.788	2	90.394	0.069	0.933
	Within Groups	39264.545	30	1308.818		
	Total	39445.333	32			

Taken together, the results reveal persistent stereotypes across students, preservice teachers, and inservice teachers, with only slight variation among groups. This raises important questions: Why do these narrow images of STEM professionals endure despite decades of efforts to promote diversity? What cultural, educational, or media influences continue to shape these

perceptions? These findings invite closer examination of how children's literature, popular media, and classroom practices might reinforce or challenge stereotypes. The following discussion explores these possibilities and considers how such influences impact the ways students and teachers envision STEM careers.

Discussion

Perception and stereotypes

Why do children possess this perception and stereotypes about STEM professionals? Looking at children's literature, University of Wisconsin's Cooperative Children's Book Center (CCBC) (2024) [17] discovered that of the 3,203 books received from United States Publishers in 2023, 14.2% were by a Black author, and 15.8% contained Black characters. These percentages increased from 2018 (5.8% by and 11.6% about). Two percent of books were written by Indigenous authors, and 2.1% contained indigenous characters. There were 18.3% by Asian

authors, and 11.9% with Asian characters. Latine authors represented 11.8% and 9.1% of characters. There were .12% of Pacific Islander authors and .19% of characters. Arab authors represented 1.2% of authors and .97% of the characters. Table 7 illustrates that despite some recent gains, the overall proportion of children's books authored by or representing diverse groups remains relatively low. This limited exposure in early literature likely contributes to the persistence of narrow stereotypes about STEM professionals, as children rarely encounter stories that normalize diversity in these roles

Table 7: Children's and YA Books By and/or About Black, Indigenous and People of Color Received by the CCBC U.S. Publishers Only 2018-2023 (reprinted with permission from Books by and/or about Black, Indigenous and People of Color 2018-2023. University of Wisconsin-Madison School of Education (2024).

Year	Books Received at CCBC (US Pubs)	Black/ African		Indigenous		Asian		Latine		Pacific Islanders		Arab	
		By	About	By	About	By	About	By	About	By	About	By	About
2023	3,203	454 (14.2%)	505 (15.8%)	63 (2%)	68 (2.1%)	586 (18.3%)	381 (11.9%)	379 (11.8%)	291 (9.1%)	4 (.125)	6 (.19%)	39 (1.2%)	31 (.97%)
2022	3,176*	453 (14.3%)	450 (14.3%)	36 (1.1%)	47 (1.5%)	578 (18.2%)	344 (10.8%)	354 (11.1%)	232 (7.3%)	8 (.25%)	14 (.44%)	30 (.94%)	24 (.76%)
2021	3,196*	307 (9.6%)	441 (13.8%)	47 (1.5%)	62 (1.9%)	466 (14.6%)	337 (10.5%)	320 (10%)	236 (7.4%)	6 (.19%)	6 (.19%)	22 (.69%)	22 (.69%)
2020	3,265*	253 (7.7%)	402 (12.3%)	27 (.83%)	41 (1.3%)	388 (11.9%)	310 (9.5%)	233 (7.1%)	198 (6.1%)	1 (.03%)	5 (.15%)	17 (.52%)	22 (.67%)
2019	3,752	219 (5.8%)	461 (12.3%)	31 (.83%)	45 (1.2%)	396 (10.6%)	336 (9.0%)	241 (6.4%)	236 (6.3%)	4 (.11%)	5 (.13%)	18 (.48%)	33 (.88%)
2018	3,352	195 (5.8%)	389 (11.6%)	27 (.81%)	34 (1.0%)	356 (10.6%)	309 (9.2%)	212 (6.3%)	244 (7.3%)	2 (.06%)	6 (18%)	15 (.45%)	24 (.72%)

Children's book editors are predominantly white females and traditionally "publishing houses are run by white men," explains Robin Adelson, Executive Director of the Children's Book Council (personal communication, June 2017). Scholastic executive editor Andrea Davis Pinkney, who is African-American and has worked in the field for nearly 30 years (personal communication, June 2017). "It takes significant effort to find authors [of any race] who can tell great stories that will stand the test of time," she says, "Then there's the challenge of finding books that children across all ethnicities actually want to read."

When speaking with colleagues from P-12 schools, post-secondary institutions, and industry, it is hypothesized that social media has played a role in students' perceptions. There was a question raised about the influence of school professionals and their perceptions of STEM professionals. Efforts need to be made to educate pre and inservice teachers on the realities of STEM professions and professionals as well as methods to introduce and sustain these facts in the classroom.

Media representations play a crucial role in shaping public perceptions of STEM professionals. For instance, Li (2016) [18] explored the impact of "The Big Bang Theory," a popular television sitcom, on audience perceptions of scientists. The study revealed that although the show made science more engaging and accessible, it also perpetuated traditional stereotypes of scientists. This finding aligns with other research that underscores the media's significant influence in maintaining these stereotypical images [19]. Therefore, it is essential to critically engage with media portrayals to challenge and expand the public's understanding of who can be a STEM professional.

Historically, the over-representation of white males in STEM fields in the United States has contributed to a self-perpetuating cycle of underrepresentation of other groups. Significant efforts have been made over the past 50 years to address and rectify these imbalances [13,14]. Despite these efforts, data indicate that stereotypes and perceptions of STEM professionals remain largely unchanged. Moving forward, it is crucial to normalize the representation of women, people of color, people with varied abilities, and other underrepresented populations in STEM to continue making meaningful progress in diversifying these fields.

The persistence of these stereotypes highlights the need for continuous efforts to present diverse representations of STEM professionals. The findings of others highlight that while media can make science accessible and engaging, it often fails to provide inclusive portrayals of STEM professionals. This underscores the need for critical engagement from media producers and educational policymakers. This includes using materials that show diverse professionals in varied settings, such as the book "What Does a Scientist Look Like?" and engaging students in activities like Citizen Science. Collaboration with organizations like National Geographic, NASA, and JASON Learning can also help. Initiatives like Dow STEM Ambassadors, which bring diverse professionals into schools, are crucial.

Role of educators

Educators at the preservice and inservice levels are pivotal in changing perceptions, which remains problematic if teachers reflect the attitudes that need to shift. Teacher educators and professional development providers and educative curriculum

materials need to support expanding teachers' view of STEM professionals so that they can help by incorporating diverse and accurate representations of STEM professionals in their teaching materials and discussing the impact of stereotypes with students [5,3].

Conclusion

The enduring stereotypes surrounding STEM professionals, particularly scientists, are deeply rooted in historical and cultural contexts that have long favored the portrayal of white males as the predominant figures in these fields. Despite concerted efforts over the past several decades to diversify the representation of STEM professionals, these stereotypes persist among both students and educators. This study's findings corroborate earlier research, indicating that significant work remains to alter these entrenched perceptions.

Educational institutions, policymakers, and media producers must collectively address the nuanced and multifaceted nature of these stereotypes. The portrayal of scientists and other STEM professionals in media has a profound impact on public perception, shaping how young people and educators view these careers. While shows like "The Big Bang Theory" have popularized science and made it more relatable, they also diminish some stereotypes while reinforcing traditional stereotypes that can dissuade underrepresented groups from pursuing STEM careers. Therefore, it is imperative that media representations become more inclusive and accurately reflect the diversity of individuals working in STEM fields today.

Furthermore, the role of educators in shaping students' perceptions of STEM cannot be overstated. Both preservice and inservice teachers must be provided with professional development opportunities that explicitly address the issue of stereotypes in STEM. Educative curriculum materials should be designed to highlight diverse role models and present STEM careers in varied and dynamic contexts. By doing so, educators can help students visualize themselves in these roles, thereby increasing their interest and engagement in STEM subjects.

Moving forward, targeted interventions are necessary to dismantle the pervasive stereotypes that hinder the participation of women, people of color, and other underrepresented groups in STEM. This includes integrating more diverse and realistic portrayals of STEM professionals in educational content and media, as well as fostering an inclusive classroom environment where all students feel represented and valued. Collaborative efforts between educational institutions, media, and STEM industries can help create a more inclusive narrative that not only reflects the reality of the diverse contributions to STEM but also inspires a new generation of scientists, technologists, engineers, and mathematicians from all backgrounds.

Transforming perceptions of STEM professionals requires a comprehensive and ongoing effort. To change stereotypes, we must tackle this issue on multiple fronts—through media, education, and policy. By doing so, we can shift the narrative and foster a more equitable and inclusive future for all aspiring STEM professionals. This change is crucial not only for those directly impacted but also for the overall advancement of science and technology, which benefits from diverse perspectives and innovation. Achieving this transformation involves educators, policymakers, and media producers presenting a range of accurate and diverse role models, allowing all students to see themselves in these fields.

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