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Underrepresentation of Minoritized Groups in STEM Education: A Metasynthesis Review

Kate Neally
Illinois State University, kseibring@gmail.com

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Cover Page Footnote

Kate Neally (309)825-7789 kneally@iwu.edu Dr. Allison Antink-Meyer and Dr. Ryan A. Brown Co-Editors Journal of STEM Teacher Education March 15th, 2022 Dear Dr. Antink-Meyer and Dr. Brown: I am delighted to re-submit with minor revisions an original article entitled “The Underrepresentation of Minoritized Groups in STEM Education: A Metasynthesis Review” for consideration for publication in the Journal of STEM Teacher Education. This manuscript synthesizes current research on the possible influences impacting the underrepresentation of People of Color in STEM education. This article has been revised based on the comments of the reviewer throughout the article. These revisions have involved minor wording changes and introducing CRT framework. I believe this manuscript is suitable for publication by the Journal of STEM Teacher Education because it reviews the issues within the STEM classroom that are impacting Students of Color. This manuscript builds a paradigm for future studies in the area of diversifying STEM education. The following manuscript has been revised for this journal and is not published and is also not under consideration for publication elsewhere. There are no conflicts of interest, but I do request respectfully that to go through the manuscript and understand it is appropriate for your journal. Thank you for your consideration. Sincerely, Kate Neally, Ed.D Illinois State University

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Underrepresentation of Minoritized Groups in STEM Education: A Metasynthesis Review

Kate Neally
Illinois Wesleyan University

ABSTRACT

This metasynthesis review analyzes the possible influences impacting the underrepresentation of People of Color (POC) in science, technology, engineering, and mathematics (STEM) education. Underrepresented minoritized (URM) groups are defined in this article as Black and Latinx populations due to their low representation in STEM education professions (National Science Foundation, 2019). This review explores the possible influences at the high school and undergraduate levels in STEM and education. Previous research has explored the racism impacting the underrepresentation of POC in both STEM and education, but little research has examined the intersectionality of STEM education. The purpose of this metasynthesis review is to analyze the existing research on SOC's experiences in STEM and education in order to better understand the underrepresentation of minoritized groups in STEM education.

Keywords: STEM education, Students of Color, Teachers of Color, underrepresented minoritized groups, STEM, education

As the student population becomes more racially diverse, science, technology, engineering, and mathematics (STEM) teachers continue to be predominately White (National Science Foundation, 2019). This metasynthesis review analyzes the possible influences impacting the underrepresentation of People of Color (POC) in STEM education. In this study, underrepresented minoritized (URM) groups include Black and Latinx populations due to their disproportionate numbers in the STEM teaching profession. This article reviews the racial barriers at the high school and undergraduate levels in STEM education. The purpose of this study is to identify in the literature the possible influences on URM groups in STEM education and analyze these influences to better understand the marginalization taking place in STEM education.

According to the National Science Foundation (2019), science and engineering pre-service teachers consist of the following racial demographics: 77% White, 9% Black, 8% Latinx, 4% Asian, and 2% other. This representation is not equivalent to the racial makeup of the student population, which in 2017 consisted of 48% White, 15% Black, 27% Latinx, and 10% other (National Center for Education Statistics, 2020). Asian and Indigenous groups were not included in this analysis due to their lower student population, though analysis of these groups is an

important area of study. Although racial diversity in the teaching profession is increasing, it is at a much slower rate than the growth of diversity in the population of students (Ingersoll et al., 2019). Racial representation is important for creating an equitable education for Students of Color (SOC). When a SOC aligns with the race of their teacher, this is defined as race congruence. Race congruence can have a positive impact on a SOC's academic achievement (Fox, 2016; Grissom & Redding, 2016; Jacoby-Senghor et al., 2016) and overall educational experience (Burciaga & Kohli, 2018; Cheng, 2019). Previous research has explored the racism impacting the underrepresentation of POC in both STEM and education, but little research has examined the intersectionality of STEM education. The purpose of this metasynthesis review is to use a Critical Race Theory (CRT) lens to analyze the existing research on SOC's experiences in STEM and education in order to better understand the underrepresentation of minoritized groups in STEM education.

First, a summary of the selection procedure for the articles in this review is described. Then, the results are presented in two interrelated subsections on (a) possible influences in STEM and (b) possible influences in education. Finally, the article concludes with a discussion on practice/policy implications and research recommendations.

Critical Race Theory

The CRT framework has been used in education research to critically examine the impact of race on the inequities in education (Ladson-Billings, 1998; Solórzano et al., 2000). The goal of this theoretical framework is to expose the racism taking place, then find solutions to address the problem (Brown, 2014; Ladson-Billings, 1998; Sleeter, 2017). This research utilizes CRT to analyze the underrepresentation of minorized groups in STEM education. The goal of this research is to analyze the underrepresentation of SOC in the STEM education pipeline. This metasynthesis review analyzes the findings of previous research to examine which possible influences are impacting SOC's pursuit of STEM education. Possible influences are defined as experiences in K-12 or post-secondary education that could influence a SOC's pursuit of STEM education. The articles were reviewed with a CRT lens to determine common themes.

Method

Literature Search Strategy

Metasynthesis is a systematic approach to reviewing literature. The process involves combining and synthesizing characteristics from qualitative and quantitative studies. The purpose of a metasynthesis analysis is to generate a holistic interpretation of a phenomenon while still preserving the uniqueness of each individual study (Mays et al., 2005). The goal of this article is to use metasynthesis to systematically review recent literature on the experience of URM groups in STEM education. Previous research has primarily focused on the underrepresentation of POC in either STEM or education. This article examines the intersection of STEM and education to provide a better understanding of how institutional racism influences the disproportionate nature of racial representation in STEM teaching. The research questions that framed this research were: What are the possible influences impacting the underrepresentation of minoritized groups in STEM and education? How do these influences impact the STEM education pipeline?

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Selection Procedures

Two comprehensive searches were conducted using EBSCO, in order to answer the research question. The two searches included possible influences in STEM and education. The comprehensive search of possible influences in STEM was conducted using the following search terms: "STEM" AND "racial minorities" OR "Black" OR "African American" OR "Latinx" OR "Latino" OR "Hispanic" OR "Students of Color". The search criteria included recent peer reviewed journal articles published from 2015 to 2021. The number of available articles was 117,551. After eliminating those related to an agricultural or the medical meaning of the word STEM (e.g. plant stems, stem cell research), there were 1,080 available articles focused on pursuing STEM. The second comprehensive search of possible influences impacting entering the education field was conducted using the following search terms: "preservice teachers" AND "racial minorities" OR "Black" or "Latinx" or "Students of Color" or "People of Color" or "Teachers of Color". The search criteria included recent peer reviewed journals published from 2015 to 2021. The number of available articles was 1,083.

The retrieved articles included a variety of qualitative, quantitative, and mixed methods studies. The author began screening titles and abstracts of the initial list of articles for studies that fulfill the inclusion criteria. The inclusion criteria included: (a) being empirical studies that were peer-reviewed and published in scholarly journals, (b) having been recently published, between 2015 and 2021, (c) participants included Black and/or Latinx high school or undergraduate students, and (d) focused on the possible influences in STEM, education, or STEM education. References were also checked on each coded study to locate additional articles. A total of 58 articles were reviewed, including 35 related to SOC pursuing STEM, 21 articles related to the pursuit of a degree in education, and 2 articles related to becoming a STEM educator.

Once the articles were collected, the coding process involved categorizing articles. There were three tabs created in the document including STEM, education, and STEM education. Early in the analysis process, the researcher discovered the lack of articles focused on STEM education, moving the focus of this metasynthesis review to possible influences in STEM and education. The researcher analyzed each article individually and categorized the articles into emerging themes, for example microaggressions or hostile academic environment. Themes were added throughout the process if an article did not fit a current theme in the document. It was possible for articles to fall into more than one theme if the research found two different possible influences. A constant comparative method was used as the articles were revisited as additional themes continued to emerge during the analysis process (Kolb, 2012). In the coding process, the researcher also included the type of study (qualitative, quantitative, or mixed methods), the demographics of participants, and the education level of the participants. In this review, the author synthesizes the findings of recent research and provides direction for future research on URM groups in STEM education.

Results

Possible Influences in STEM

In the metasynthesis analyses, 35 articles were found that related to possible influences impacting URM groups in STEM. The majority of these articles focused on SOC's undergraduate STEM experiences. Though some studies focused on intersecting identities, such as Black women, many articles analyzed the overall experience SOC. When reviewing the articles, five main

possible influences emerged that challenge SOC's success in STEM: (a) K-12 experiences and STEM exposure, (b) hostile academic environment, (c) stereotype threat, (d) educator relationships, and (e) peer support. These possible influences do not represent the complete list of factors, but are the themes represented within educational research studies. These categories emphasize the problematic areas impacting the underrepresentation of minoritized groups in STEM. The recent research focuses on either the challenges or successes in a SOC's pursuit of STEM. Table 1 contains the possible influences in a SOC's educational journey in STEM and how many articles contained data related to these influences. Some articles were included in multiple STEM influences.

Table 1
Possible Influences in STEM Articles

Possible Influences for SOC in STEM	Number of Articles
K-12 Experiences & STEM Exposure	7
Hostile Academic Environment	11
Stereotype Threat	10
Educator Relationships	9
Peer Support	7

K-12 Experiences & STEM Exposure

Although majority of the articles (29 of 35) in this review focused on retaining SOC at the undergraduate level, K-12 experiences can include possible influences that impact STEM recruitment. For example, racism and microaggressions from K-12 STEM teachers can discourage SOC's interest in pursuing STEM (King & Pringle, 2018; Shephard, 2020). Teachers can bring their racial biases into the classroom leading to discrimination of SOC. In Shephard's (2020) study, science teachers evaluated their SOC less favorably than their White students. Although there are many studies that analyze the negative impact of racism and microaggressions (Gershenson et al., 2016; Marrun et al., 2019; Suarez-Orozco et al., 2015), there are not many that focus specifically on the STEM classroom. These negative experiences can cause students to lose interest and motivation in STEM classes and ultimately deter them from wanting to pursue STEM (King & Pringle, 2018; Shephard, 2020). Along with negative experiences with teachers, students may also lack significant STEM exposure during their K-12 education.

Many SOC majoring in STEM struggle to keep up with their coursework due to unequal access to academic preparation (Stipanovic & Woo, 2017). Although this challenge is not exclusively for SOC, many URM students attend high schools in low-income school districts that have fewer resources than primarily White populated school districts (Stipanovic & Woo, 2017). This can include limited high-level courses and schools may have to restrict enrollment for Advanced Placement classes (Stipanovic & Woo, 2017). URM students from low-income school districts can be put at an immediate disadvantage when they enter college due to the lack of exposure to high level math and science courses. The more Advanced Placement classes an URM student has taken,

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the higher the likelihood of persisting in a STEM major (Gipson, 2016). This emphasizes the impact that K-12 has on the inequalities in the STEM pipeline. STEM enrichment programs are one strategy to provide SOC with engaging and meaningful STEM learning experiences (Alvarado & Muniz, 2018; King & Pringle, 2018). Exposure to STEM early in education can increase students enrollment in STEM AP classes and ultimately impact majoring in STEM (Alvarado & Muniz, 2018). These studies suggest, starting in early education settings, that there are many racial injustices in the current education system. The equity issues continue from the K-12 setting to the undergraduate level when a SOC decides to major in a STEM subject.

Hostile Academic Environment

SOC have described the college STEM education setting as a hostile racialized environment (Jones, 2019; Leath & Chavous, 2018; Ortiz et al., 2019; Winkle-Wagner & McCoy, 2018). Racism and racial microaggressions are not single incidents but are embedded in college campuses (McGee, 2016). SOC experience microaggressions from their STEM professors, advisors, and peers (Lee et al., 2020). These racially charged incidents involve deficit thinking, dismissive comments, racist jokes, and racial slurs (Lee et al., 2020). The discrimination not only creates an unhealthy learning environment, but is negatively associated with math/science self-efficacy (Hall et al., 2017) and retention in STEM (Lee et al., 2020; Park et al., 2019). The hostile STEM environment leaves students feeling lonely and devalued (Green et al., 2018; Lee et al., 2020). The unwelcoming academic environment can cause students to question if they belong in STEM (Lee et al., 2020).

The exclusionary idea of who belongs in STEM starts as early as the introductory mathematics courses (Leyva et al., 2020). It is essential for STEM retention that SOC have positive experiences in their entry level classes (Stokes et al., 2015). Another strategy to increase the number of SOC in STEM departments is to create a more inclusive curriculum. The more inclusive the STEM curriculum, the greater the diversity of the student composition (Garibay & Vincent, 2018). For example, Garibay and Vincent (2018) analyzed the impact of an inclusive curriculum on the enrollment of SOC in environmental science. Inclusive curriculum included curriculum that focused on environmental justice and community engagement. They found a statistically significant connection between inclusive curriculum and racially diverse student enrollment. Curricular components need to be critically analyzed because they imply what and who is valued in their education (Garibay & Vincent, 2018). In order to create a diverse and welcoming educational experience, the racism ingrained in the STEM environment needs to be deeply examined to support SOC in their pursuit of STEM.

Stereotype Threat

The negative STEM environment can involve stereotyping and racial stigmatization from classmates and professors (Leath & Chavous, 2018; Leyva et al., 2020; McGee, 2016). Due to the current lack of adequate representation of POC in STEM fields, many SOC experience stereotype threat relating to their ability to be successful in STEM (Ben-Zeev et al., 2017; McGee, 2018). Stereotype threat is defined as "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" (Steele & Aronson, 1995, p. 797). Steele and Aronson (1995) researched the impact of stereotype vulnerability on standardized assessments. The researchers found that Black participants were more vulnerable to negative stereotypes leading to self-doubt

and lower test scores. Although this experiment focused specifically on standardized assessment scores, the current underrepresentation of POC in STEM fields can likely instill the same self-doubt. Currently, 69% of STEM jobs are filled by White individuals, while only 9% are Black and 7% Latinx (Funk & Parker, 2018). The implications of Steele and Aronson's (1995) work in the STEM setting is that students may doubt their success in STEM classes because of the unconscious perception of STEM being a primarily White dominated field.

The desire to challenge stereotypes and prove themselves capable can put a lot of pressure on students, negatively impacting their mental and physical health (McGee, 2018). Students can feel emotionally exhausted from fighting stereotype threat. This is called racial battle fatigue (McGee, 2016, 2018). Many SOC drop their STEM major due to the anxiety and pressure associated with stereotype threat (McGee, 2018). Similarly, students can experience imposter syndrome, which is the belief that they do not belong in STEM. This can cause students to doubt their own ability and constantly question themselves (Collins, et al., 2020). Stereotype threat and imposter syndrome can drastically impact the likelihood of success in STEM subjects.

Educator Relationships

Educator support and relationship-building is an important component to SOC's success in STEM (Green et al., 2018). In the beginning of undergraduate study, it can be challenging to build connections with professors due to the large-enrollment in entry level classes (Rainey et al., 2019). For SOC who are able to interact with faculty, many describe a strained or non-existent relationships with their professors (Lancaster & Xu, 2017). Other students experienced negative interactions where their professors invalidate their academic ability (Burrell et al., 2015; Fries-Britt & White-Lewis, 2020), view them through a deficit lens (Green et al., 2018), and try to weed them out of STEM (McCoy et al., 2017). Although SOC describe the importance of faculty support, many students either struggle with building relationships or have negative interactions that discourage these connections. Existing research has also analyzed the point of view of professors. McCoy et al. (2015) found that professors use colorblind terminology to describe their SOC and tend to highlight their SOC's lack of commitment and preparation. Race neutral language reinforces racial biases and can illuminate why it is challenging for STEM professors to build connections with SOC.

SOC, particularly Black male students, desire meaningful and sincere relationships with their professors (Fries-Britt & White-Lewis, 2020). Positive faculty relationships can involve professors encouraging and mentoring SOC (Gasman et al., 2017; Green et al., 2018; Lancaster & Xu, 2017). Mentorships can include an informal relationship (Lancaster & Xu, 2017) or a structured research partnership (Gasman et al., 2017). Making connections with professors allows students to engage with someone in the field about their STEM barriers and interests. SOC feel assurance in their decision to major in STEM when they have positive interactions with their STEM professors (Nguyen et al., 2021; Rainey et al., 2019). If students do not feel supported by their faculty, they may seek out peer support groups to help them navigate their STEM experience.

Peer Support

SOC may look for support from their peers to overcome hostile STEM environments. However, students can have trouble building connections with their White classmates when there are not many other SOC in their major (Green et al., 2018; Jones, 2019). This feeling of isolation

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and lack of community leaves SOC less satisfied with their academics than White students (Leath & Chavous, 2018). Students who do not have access to support groups can feel unsupported in their STEM journey.

Peer support groups can include student generated groups, organization on campus, or a summer bridge program (Ortiz et al., 2019; White et al., 2018). Particularly for Black students, the most beneficial support groups are Black student organizations related to a student's STEM major (Lancaster & Xu, 2017). Peer support groups provide advice, study groups, and shared experiences (Burell et al., 2015). This communal climate can help lift students up and increase confidence in their own abilities (Nguyen et al., 2021). There is a positive association between a student being surrounded by a diverse group of friends and their math/science self-efficacy (Hall et al., 2017). STEM degree programs that have a higher average of enrolled SOC were significantly more likely to have an increase in enrollment of SOC in future years (Garibay & Vincent, 2018). Diversity at the university, and within a major, matters to how SOC experience inclusion (Winkle-Wagner &McCoy, 2018). The isolation that SOC can feel in a White dominated STEM environment and the benefits of peer support groups are important resources needed in undergraduate STEM programs (Lancaster & Xu, 2017).

This metasynthesis review analyzes the current barriers in STEM education that are impacting SOC's pursuit of a STEM profession. Some articles focus on the racialized barriers existing in education, while others emphasize the needs and wants of SOC. The racism in the K-12 setting can be a detriment for students' interest in STEM, but there is a lack of research in this area. It is hard to know specifically when the possible influences in K-12 occurs, or whether it is a collective set of events that deters a student from STEM. SOC also have additional challenges once they reach the undergraduate level. There are both internal and external struggles for SOC in their STEM journey. Internally students struggle with stereotype threat, imposter syndrome, and a sense of belonging. Externally students struggle with structural racism in STEM that they see in the academic environment, with their professors, and peers. The STEM synthesis describes the possible influences and racialized barriers across multiple areas of education that impact the underrepresentation of SOC in STEM. STEM education cannot be deemed successful and equitable "if that education is not effective for those students who have been historically marginalized and excluded from the community of scientists, mathematicians, and engineers" (Basile & Murray, 2015, p. 261).

Possible Influences in Teaching

According to the National Center for Education Statistics (2018), in the 2015-2016 school year, 80% of educators consisted of White teachers, while only 9% identified as Latinx and 7% Black. This racial breakdown is not representative of the diverse student population in the public school system (National Center for Education Statistics, 2020). The underrepresentation of Teachers of Color (TOC) is one component of the structural racism experienced by SOC throughout their educational journey. This metasynthesis review found 21 articles on the possible influences of URM groups in education, primarily focusing on the experiences of preservice TOC (PTOC). When reviewing the articles on possible influences in education, three themes emerged as racial barriers in a SOC's pursuit of education: (a) K-12 experiences, (b) lack of diversity in teaching, and (c) racism in teacher preparation programs. These categories emphasize the areas in education impacting the underrepresentation of minoritized groups in teaching. Table 2 contains the possible

influences in education and how many articles contained data related to these influences. Some articles were included in multiple STEM influences.

Table 2
Possible Influences in Education Articles

Possible Influence for SOC in Education	Number of Articles
K-12 Experiences	6
Lack of Diversity in Teaching	4
Teacher Preparation Programs	13

K-12 Experiences

Negative K-12 experiences can either discourage SOC from pursuing teaching (Goings & Bianco, 2016; Marrun et al., 2019) or drive SOC to be the teacher they never had themselves (Brown, 2018; Plachowski, 2019). Leech et al. (2019) found that high school SOC are significantly less interested in teaching than their White classmates. They also rated their learning experience lower than White participants. Adverse learning conditions can involve microaggressions and other forms of racism from teachers and classmates (Goings & Bianco, 2016; Marrun et al., 2019). These possible influences in K-12 schooling can deter SOC from wanting to be in a work environment where they have experienced trauma and oppression.

Conversely, other SOC used their negative experiences as a motivator to become a teacher and be the representation that was lacking in their education. SOC described feeling dismissed by their K-12 teachers (Brown, 2018), experiencing microaggressions, and deficit expectations (Bryson, 2017; Goings & Bianco, 2016). These possible influences can shape a SOC's teaching philosophy and pedagogy by focusing their teaching on changing the system (Bryson, 2017). These SOC are committed to being teachers who recognize and address issues with race and become an advocate for their future students (Brown, 2018). The social justice pedagogical focus not only allows SOC to have a race congruent teacher, but have someone who supports and advocates for them in the classroom.

While the majority of the research focuses on negative experiences in K-12, positive experiences can also have a large impact on a SOC's interest in pursuing teaching (Goings & Bianco, 2016; Plachowski, 2019). Though the SOC in Plachowski's (2019) study still had twice as many negative experiences as positive ones, their positive experiences and personal resilience pushed them to become educators. SOC described the importance of having a teacher who truly cares about them and has high expectations. These meaningful teacher-student interactions not only impact a SOC's experience in education, but can also impact the representation of marginalized groups in teaching. The research on K-12 experiences brings to light the resilience SOC must possess in order to become educators and possibly re-enter the classroom environment where they experienced trauma (Plachowski, 2019). These are racial obstacles that White students, White preservice teachers, and White teachers do not have to overcome in order to enter the profession.

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Lack of Diversity in Teaching

Another reason for SOC's disinterest in teaching is the lack of racial representation in schools. Marrun et al. (2019) interviewed college SOC to learn why they are not interested in pursuing teaching. The participants said they never considered teaching because they did not have a role model who looked like them in a teaching position at their school. Students used the phrase "Whiteness in education" to describe the lack of diversity in the teaching profession and the struggle to build connections with their White teachers (Marrun et al., 2019). If SOC do not have a teacher that looks like them, it can be hard to see teaching as a future profession (Gist et al., 2018; Marrun & Clark, 2020). SOC also described the fear of challenging work conditions in K-12 schools because of the low representation of other TOC (Bergey et al., 2019). The underrepresentation of TOC could make education an unwelcoming work environment.

Increasing the number of TOC provides SOC with a role model in the education system. Having a role model in a teaching position allows students to see an individual with a similar background and culture who have succeeded in education. Many preservice Teachers of Color (PTOC) feel pushed to teach in order to build connections with their future SOC (Caldas, 2018; Marrun & Clark, 2020). Their goal is to disrupt racial stereotypes and to be an ally for students (Gist et al., 2018). Having positive role models and racial representation in teaching can have an instrumental impact on SOC's success in school and their future aspirations.

Racism in Teacher Preparation Programs

Teacher preparation programs are intended to support preservice teachers in their journey to become an educator. Unfortunately, many SOC have negative experiences in their teacher preparation programs and field experience that can deter them from pursuing teaching. Since the majority of teachers are White, it is not surprising that the demographic of preservice teachers is also primarily White. Due to the lack of racial representation in teacher preparation programs, SOC can feel isolated and disconnected from their peers (Amos, 2016; Cheruvu et al., 2015; Gist, 2017). This is particularly important when thinking about a teacher preparation program as a teacher's first peer network system. Other negative experiences with teacher preparation programs include SOC feeling silenced and devalued, a hostile academic environment, and a lack of faculty support (Bell & Busey, 2021; Black & Cook, 2018; Cheruvu et al., 2015). The lack of support from their peers, faculty, and environment can make it challenging academically.

It is important for teacher preparation programs to realize that SOC have unique needs but also strengths that should be utilized (Amos, 2016; Caldas, 2018; House-Niamke & Sato, 2019; Kondo & Bracho, 2019; Morales, 2018). When PTOC experience exclusion from curriculum, they may perceive that their background is undervalued compared to their White classmates. Curriculum in teacher preparation programs needs to promote inclusion so that all students feel represented. SOC described positive experiences of representation in programs that cultivate social justice and incorporate diverse perspectives (Brown, 2018; Gist, 2017; Pham, 2018). Inclusion and valuing the experiences of SOC is important to help students not only feel part of the curriculum but part of teacher education.

PTOC can also have negative field experiences that involve racism and a hostile teaching environment (Bell & Busey, 2021; Rodriguez-Mojica et al., 2020). Students may experience microaggressions during student teaching with their cooperating teacher. Students described incidents related to racially insensitive comments about their hair and their language (Bell &

Busey, 2021). Others felt invisible, stereotyped and uncomfortable with the teacher who was supposed to be their mentor (Rodriguez-Mojica et al., 2020). This negative environment can make it difficult for students to immerse themselves in what could be their future profession. Additionally, PTOC described being unable to include social justice principles in their teaching due to the opinions of their cooperating teacher (Rodriguez-Mojica et al., 2020). Students are unable to get the full teaching experience due to being silenced by the current teaching community. These negative field experiences can deter a student from graduating with a teaching degree and becoming a teacher.

The procedure to get a teaching license can be a demanding process and may deter future educators (Bergey et al., 2019). Many states require preservice teachers to pass a standardized assessment such as the Praxis or Educative Teacher Performance Assessment (edTPA) in order to receive their teaching license. These standardized requirements disproportionately affect SOC (Ingersoll et al., 2019; Petchauer et al., 2018; Williams et al., 2019). Candidates who are student teaching in urban and rural schools, on average, score significantly lower on edTPA than candidates in other schools (Williams et al., 2019). Scorers' implicit biases have also been discovered when analyzing edTPA passing rates for diverse teacher candidates. Researchers have found that Black candidates have statistically lower pass rates than White candidates (Petchauer et al., 2018; Williams et al., 2019). These biases can occur during the review of the videoed lesson when the scorers are able to see and hear the teacher. Although the scorers were trained to not discriminate during their analysis, bias remains a problem.

The adoption of standardized tests such as edTPA has been seen as the adoption of a "color-blind policy" that ignores all historical inequities and attempts to minimize racism by creating a standardized model (Tuck & Gorlewski, 2016). These teaching license requirements further the gap of inequities in schooling because they ignore the institutional racism in education and include racial biases. Instead of creating equity through standardization, many teaching license assessments further the inequalities in education and maintain racial hierarchies.

There are a variety of possible influences throughout schooling that can deter a SOC from pursuing education. These experiences occur throughout the education pipeline including K-12 education, teacher preparation programs, field experience, and the standardized licensure process. These barriers display the structural racism throughout the education system that impacts the underrepresentation of minoritized groups in teaching.

Discussion

When the researcher conducted this metasynthesis analysis of recent STEM and education articles, two articles emerged that fit the inclusion criteria focusing on STEM education (Mensah & Jackson, 2018; Morettini, 2017). In Morettini's (2017) research, she analyzed the impact of a SOC's race on their choice to pursue STEM education. Along with their decision to teach in a school that has a high percentage of SOC. Due to their own racialized experiences in education, the participants in this study wanted to become teachers to be an advocate and a role model for SOC. Although this research focused on those pursuing STEM education, the emphasis was on the desire to become a teacher more than the specifics of teaching STEM.

Mensah and Jackson (2018) analyzed the experience of PTOC in a science methods course. In the course, students learned about traditional science as White property and how to give ownership to their SOC in the science classroom. This inclusive curriculum used a multicultural

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interdisciplinary approach to teach science. Students were able to apply their experiences to the learning process and their future classroom. The goal of the class was to help PTOC learn how to best support and engage their SOC in the science classroom. The methods course also allowed PTOC to see themselves as belonging in the field and affirmed their desire to become science teachers. This study encourages teacher preparation programs to create a welcoming environment that allows PTOC to feel included in their program. However, due to the lack of research on the intersectionality of STEM and education, more research needs to be conducted about ways to recruit SOC in K-12 education and retain PTOC in undergraduate.

The current teaching population consists of primarily White educators who are responsible for educating a diverse group of students. Diversifying STEM education is important because of the many benefits for SOC being represented in the STEM teaching population (Gershenson et al., 2016; Jacoby-Senghor et al., 2016). Primarily, research has focused on the racialized barriers to enter either STEM or education, this research brings those barriers into view through one analysis that illuminates the intersectionality of the challenges to pursuing STEM education.

Limitations

The goal of this research was to analyze recent research to see possible influences in STEM education. This research generalizes the experiences of SOC and does not consider the intersectionality of the individuals. As research continues, it is important to focus on the intersectionality of identities. One form of intersectionality that requires additional research is the experience of Women of Color, since women and POC are underrepresented in STEM (National Science Foundation, 2019). It is important to understand that not all POC have the same experiences and racialized barriers when moving forward in the best ways to support SOC pursuing STEM education. The goal of this analysis was to be a starting point for future research.

Overview of Findings

The previous articles review the possible influences impacting the underrepresentation of minoritized groups in STEM professions, teaching fields, and more specifically STEM teaching fields. Possible influences can occur in K-12 schooling that impact a SOC's pursuit of STEM including racism, microaggressions, and a lack of adequate exposure to STEM. For those majoring in STEM, the racialized experiences continue at the college level including a non-inclusive and hostile academic environment. Students also experience challenges with stereotype threat, building relationships with faculty, and finding a peer support group. These added obstacles lead to a racially disproportionate number of SOC graduating in STEM and entering a STEM profession. In order to improve the racial representation in STEM professions, the structural racism in STEM education needs to be addressed.

There are also racial barriers for SOC interested in teaching. Teaching can be seen as an unattractive profession for SOC because of the racism they experienced in K-12 settings and the lack of diversity in the field. Conversely, these negative experiences and the lack of diversity in teaching can be a motivator for PTOC to enter the classroom. Those who enter teacher preparation programs face additional obstacles during their undergraduate education. The low retention of PTOCs may be influenced by poor experiences in teacher preparation programs and unfair teaching license requirements. Previous research has studied the racial injustices at the K-12 and undergraduate level that make it challenging for SOC to become teachers. In order to diversify the

teaching profession, there needs to be more support systems in place for SOC who are interested in becoming teachers.

The possible influences that impact a SOC's pursuit of STEM or education occur during K-12 and undergraduate school. The common theme in this study is the racism in the education system impacting the underrepresentation of minoritized groups in both STEM and education. It is critical to have racial representation in the teaching profession, particularly in the STEM teaching population. Diversity among STEM teachers serves as "a powerful role in creating a future in STEM fields where People of Color feel less alienated" (Basile & Murray, 2015, p. 264). Increasing the number of TOC can impact students' STEM experience and potentially lead to more URM groups in STEM, education, and STEM education.

Directions for Future Research

Future research needs to continue to study the institutional racism taking place in the K-12 and undergraduate settings. Current research has found a disproportionate number of POC entering STEM and education fields due to possible influences of racism in education. When analyzing the explanations for the lack of POC in these fields, the findings are similar. There is a deeper racism within the culture and climate of the school system that needs to be addressed in order to give all students equitable education. SOC have negative racial barriers in K-12 settings that continue through college. This problem needs to be viewed through a critical race lens in order to understand the deeper issues and start investigating how to invoke serious change.

This metasynthesis analysis grouped the experiences of Black and Latinx populations as underrepresented minoritized groups. Future research needs to focus on the experiences of specific groups and the intersectionality of individuals in order to see the differences in experiences in STEM education. Although this research gave a broad scope of the experiences of POC, future research should focus on specific demographics.

Future research should begin analyze the intersection of barriers when SOC pursue STEM education. The majority of recent research has focused on either STEM or education as separate areas of study and it is important to understand the connection between the two. There may be additional challenges that URM groups experience when pursuing STEM education that previous research has not analyzed. The focus should continue to be on the perspective of minoritized groups in STEM education. Previous research has brought to light the institutional racism taking place in K-12 and undergraduate settings, therefore, future research needs to look at programs and implementation structures to help correct the current inequalities in the STEM education pipeline. This metasynthesis review should be analyzed by K-12 schools, teacher preparation programs, and STEM departments to better understand the challenges that SOC experience during their K-12 and undergraduate periods of entering STEM education.

Another area of study includes analyzing the racialized barriers of TOC. Education struggles with the retention of all teachers; however, TOC are leaving education at a faster rate than their White colleagues (Carver-Thomas & Darling-Hammond, 2019). Almost two-thirds of TOC work in high-poverty, high SOC, urban communities (Ingersoll et al., 2019). The turnover rate of teachers working in schools with primarily SOC is 70% greater than schools with majority White students (Carver-Thomas & Darling-Hammond, 2019). These can be challenging environments to teach in due to the lack of resources, poor working conditions, and large class sizes. It is essential

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that future research continues to find ways to provide support systems for TOC in order to resolve the high turnover rates.

Policy Implications

The policy recommendations that emerge from the literature on SOC in STEM education include recruiting more racially diverse STEM teachers, retaining TOC, and requiring anti-racist pedagogy training for all teachers. Grow your own programs are one option as a pathway to increase diversity in the teaching profession from within communities (Morales, 2018). There are also other policies and programs in place to diversify the teaching population, but the current strategies are not keeping up with the growth in the number of SOC (Ingersoll et al., 2019). Therefore, practices, programs, and policies to recruit and retain STEM TOC needs to be intensified if schools want to make progress towards racially representing the student population.

It is also recommended to prepare all current and future teachers to teach using anti-racist pedagogy in order to begin addressing the institutional racism taking place in schools (Pierce, 2016). White teachers need to be conscious of the racism SOC experience in their educational journey and address the White privilege in the current system. School districts and teacher preparation programs should provide additional and continuous diversity and critical race theory training moving away from the color-blindness ideologies of the past in order to correct the oppression. There are many components to the institutional racism in the STEM education pipeline. It is going to take a team effort involving policymakers, researchers, and educators to create a STEM education system that is equitable for all students. If we only focus on the underrepresentation of POC in STEM education without thinking about the institutional system that causes this low representation, then we are not truly grasping the oppression in the education system.

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Authors

Kate Neally
Visiting Assistant Professor
Illinois Wesleyan University, Educational Studies
Email: kneally@iwu.edu

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