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An Exploration of Impostor Syndrome in STEM and STEM Self-Efficacy in Adolescent Learners from a Teacher's Perspective

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ABSTRACT

Over the years, there has been a surge in the demand for a proficient STEM (Science, Technology, Engineering, and Math) workforce to occupy the proliferating STEM job vacancies worldwide. The STEM workforce must be expanded in order to fill this gap. However, the reputation of STEM learning as being arduous has proven to be a deterrent to students' interest in the pursuit of STEM careers. In an expounding qualitative study, three STEM teachers were interviewed for the purpose of examining STEM Impostor Syndrome (IS) and STEM Self-Efficacy (S-SE) from a teacher's perspective. Findings suggest that teachers are sentient of the manifestation of STEM IS among students. Teachers noted that STEM IS poses a significant challenge for their interactions with students in the classroom, and also suggested that STEM IS is inversely proportional to S-SE.

Keywords: self-efficacy, STEM, STEM learners, impostor syndrome, career

INTRODUCTION

Careers and jobs in STEM (Science, Technology, Engineering and Math) are rapidly expanding around the globe, so it is imperative that countries across the world produce a competitive STEM workforce to help support that industry (WEF, 2020). However, the reputation of STEM subjects as being academically difficult discourages students from the pursuit of STEM degrees (Funk and Parker, 2018), creating a situation which requires an increasing demand for a competent STEM labor force; a demand that has been met by an inadequate supply (Jang 2016; Wang and Degol, 2016). The mismatch between supply and demand makes it crucial to discern the factors that serve as obstacles to learners' interest and pursuit of STEM careers (Blotnicky et al., 2018). Although individuals with STEM undergraduate degrees are generally paid a higher salary than those with non-STEM degrees, there is still a relatively low interest in STEM courses and careers, therefore leaving educators puzzled (Kennedy et al., 2021). To add some clarity to this issue, in the current study we sought out teachers' perspectives on the prevalence of STEM Impostor Syndrome (IS) in the classroom, and asked what implications, if any, are there for working with students who show signs of STEM IS. Teachers are often in a unique position to observe and interact with their students on a regular basis and may be more likely to notice when a student is struggling with these issues. Their perceptions of this relationship are important as they might notice indicators of IS and SE such as perfectionism, self-doubt, anxiety, and self-deprecation. A teacher who is aware of the relationship between IS and SE can use this knowledge to respond to their students in a supportive way. If IS and SE are related, and a teacher notices that a student is experiencing IS, they can provide cues or strategies to help the student increase their sense of self-efficacy (SE) and overcome their negative thoughts and feelings.

The term IS was introduced by Clance and Imes (1978) in reference to the inability to internalize success due to one's conviction that they are not intelligent enough to have accomplished a particular task, and so their success is unwarranted. SE on the other hand, is a person's belief in their ability to perform a task to the expected degree (Bandura, 1977). Our study focused exclusively on STEM self-efficacy (S-SE) beliefs since these beliefs differ by domain. Individuals' SE beliefs relate to their perceptions about their capabilities in specific settings. A person's level of SE, in this case SE in STEM, may contribute to their decision to pursue STEM subjects and a STEM career, and if S-SE is low, it is likely to trigger impostor fears. This implies that individuals who question their abilities in the implementation of their goals would prefer to avoid a field that makes them think they do not belong. The possible connection between an individual's career choices and/ or interest, is supported by the Social Cognitive Career Theory (Lent et al., 1994), which will be discussed further in the literature review.

Persons with IS tend to disparage their success and attribute it to external factors such as luck, an educator's leniency, hard work, among others while also magnifying their failures and viewing them as proof of their inadequacy and unintelligence (Wiener, 2008). The features of IS include the inability to internalize academic success, belief of their own intellectual disingenuousness, fear of being exposed as a failure, and the attribution of any successful academic performance to external factors and never their own ability (Clance and Imes, 1978). STEM IS as referenced in this study is the presence of IS in STEM subjects.

According to extant research on the subject, STEM IS could be common among early adolescent learners (Caselman et al., 2006; Collins et al., 2020). The study of STEM IS in early adolescents as well as how it may possibly be triggered by IS is imperative because of the cognitive vulnerability at that young age. If low S-SE contributes to the occurrence of STEM IS, this could support the idea that educators, through the teaching strategies they use, could reduce IS by increasing S-SE, hopefully increasing the number of students who believe they are skilled enough to pursue STEM degrees and ultimately join the workforce.

Although most previous studies on IS have involved graduate students and professionals, we chose to delve into IS in early adolescents as this, according to Social Cognitive Career Theory (Lent et al., 1994), may be where the self-perception of IS first manifests. Also, due to the domain-specificity of SE, we focused on the phenomenon in STEM only. Adolescence is a period of psychosocial development from the beginning of puberty to adulthood (10-19 years old). The uncertainty of the cognitive, psychological, and temperamental changes can create a very sensitive and precarious developmental stage for young adolescents because they are neither children nor adults (Hamburg and Takinishi, 1989). Blakemore (2019) described the period of adolescence as an especially vulnerable time in development where people are especially susceptible to mental health problems such as anxiety and depression. It was noted that an unhealthy mentality that begins in adolescence can often persist into adulthood. IS, as a mental state (Clance and Imes, 1978), tends to breed anxiety that stems from self-doubt, while serving as a gridlock that stifles students' academic and social progress (Schock, 2019). The manifestation of IS in adolescents, therefore, could create situations that negatively impact students' progress, especially in STEM domains.

As stated, majority of previous studies have measured the relationship between IS and SE in graduate students and professionals (Tao and Gloria, 2019), and to our knowledge there are hardly any published studies on the ways in which S-SE and STEM IS hinder adolescent STEM career interest. Comprehension of the connection between the two psychological constructs is essential due to its potential to suggest an indirect solution to the pernicious mental health phenomenon that is STEM IS among lower secondary school students. According to Schunk and Meece (2006), students' academic choices, performance and participation are influenced by what they believe about their ability to perform the task successfully. The self-doubt that self-imposed impostors grapple with could possibly be likened to low SE, and the discovery of a negative relationship between STEM IS and S-SE could indicate that in order to increase S-SE, and potentially positively impact the STEM workforce, educators could focus on countering IS in early adolescent learners. Our study sought to explore the manifestation of STEM IS in learning, as well as the ways in which this concept is as a result of an individual's S-SE. The next chapter provides an overview of foundational literature as well as operational definitions of these self-perceptions.

LITERATURE REVIEW

Impostor Syndrome and STEM Self-Efficacy

The aim of this study was to give an in-depth investigation into the manifestation of STEM IS and S-SE in the classroom based on teachers' interaction with their students. A person convinces themselves they are an impostor when they do not believe they deserve the academic accomplishments they have, and they choose to credit external factors for their success rather than it being as a result of their own intelligence and capabilities (Clance, 1985). IS is a mental state (Clance and Imes, 1978) whereas S-SE is a self-belief, however, both have known associations with academic outcomes (e.g., Thompson et al., 1998; Kolo et al., 2017). That being said, the ways in which the two concepts are connected is not fully understood, and not much research has explicitly and specifically studied

how IS and S-SE are associated, nor has there been an examination of if and how teachers perceive these constructs in their classroom. A critical investigation of these concepts can help with the comprehension of the ways in which S-SE contributes to the prevalence of STEM IS from a teachers' perspective while exploring the implications for classroom instruction.

Impostor Syndrome in Adolescents

Due to the scarcity of studies that center on the phenomenon of IS in early adolescents and the potential impact IS might have on stifling academic progress, this study focused on the manifestation of IS and SE in this demographic. Although majority of research about IS has focused on young adults and adults, possibly due to the superior cognitive ability of adults to self-examine, adolescents have been said to be cognitively developed enough to be introspective (Winters et al., 2021; Blakemore, 2012). In their breakthrough study of the Impostor Phenomenon, Clance and Imes (1978) posited that during the developmental period of adolescence, they struggle with the internalization of their self-perception. This is an indication of the presence of IS at that age, considering the inability to internalize one's concept or views about themselves is one major hallmark of IS. Caselman, Self, and Self (2006) in their study of 14–18-year-old adolescents found evidence of IS and also that it occurs at a similar rate as adults. Over the years, there have been very few studies of IS in adolescents. Nevertheless, those that do exist suggest that some form of IS is present in that age group. For instance, Stahl et al. (1980) in their research revealed that 55% of African American high school girls attributed their academic success to external factors, and not as a result of their own competence or intellectual capacity. High-achieving Asian high school students were also found to generally exhibit symptoms of IS, although these symptoms are said to be generated mostly due to their family educational values rather than because of the individual's self-confidence (Kang et al., 2021). While these studies provide evidence that IS is present in adolescents, they all fail to explore the academic implications from the perspective of a teacher.

Importance of Self-Efficacy

SE has been identified as possibly the most imperative element of a student's self-belief system, in their engagement and perseverance in STEM learning (Concannon and Barrow, 2012). Brown et al. (2016) suggested that it is imperative to assess and comprehend an individual's SE in order to comprehend the factors necessary for the study of STEM as well as the sustenance of STEM learning.

According to Dweck (2016), Lent (2016) and Zimmerman (2013), mindset plays a role in how individuals perceive success or failure, and SE is influenced by one's interests, outcome expectations, and knowledge of self-regulatory behaviors. Individuals are more likely to feel confident in their ability to succeed when they are interested in the task, have a clear understanding of what the outcome will be, and have the necessary skills and strategies to regulate their behavior. Motivation is also a key component of this framework, as it is what drives individuals to pursue their goals and engage in self-regulatory behaviors. The authors also posit that motivation is influenced by SE, interests, and outcome expectations, as well as an individual's mindset. In spite of the role of interest in our self-regulatory behaviors, this study did not explore this concept. We only explored teachers' perceptions of the relationship between STEM IS and S-SE. Woolf et al. (2020) found that teachers who are aware of IS and its potential impact on student success are more likely to use supportive language and strategies that encourage student SE. They went on to highlight the importance of teachers' perceptions and responses to IS, as they can have a significant impact on students' academic progress. By providing support and strategies that help students overcome feelings of self-doubt and inadequacy, teachers can help students build a more positive self-image and achieve greater success in school and beyond.

Wigfield, Tonks and Klauda (2016) found a strong relationship between middle school students' S-SE and their persistence in STEM learning. They also found that students who reported higher levels of S-SE were more likely to persist in STEM learning, even when faced with challenges or setbacks. These findings reiterate the fact that students' STEM engagement and success can be encouraged and improved with the increase of their SE, which goes to show that SE is the major component of the decision to engage in STEM learning. Research by Mau and Li (2018) support these findings with their study which reported the STEM career goals of ninth graders being predicted by science SE. They, also found there to be a significant prediction of STEM career aspirations by math and science SE.

Differences Between Impostor Syndrome and Self-Efficacy

SE and IS are distinct constructs, but they also have some similarities that support the hypothesis that IS could impact S-SE. One difference is in their respective definitions. The concept of SE was introduced by Psychologist Albert Bandura in his Social Cognitive Theory, which explained the effect of environmental, cognitive, and behavioral factors on learning (Bandura, 1991). In this theory, Bandura described SE as an individual's belief in

their own capability in effectively implementing the strategies required in achieving a goal. While SE is defined as a person's self-perception of their capabilities, and can be either positive or negative (Bandura, 1991), IS is a negative mental state only, where a person nullifies their accomplishments and /or success and attributes success to external factors such as luck (Clance and Imes, 1978). Both can be a byproduct of an individual's personality trait or as a result of other environmental factors. Research has found IS to be positively correlated with at least one of the Big Five Personality traits, namely Neuroticism, and these studies purported that the relationship is specifically derived from a particular facet of neuroticism, which is anxiety (Ross et al., 2001). Similarly, other findings indicate that SE is negatively linked with Consciousness and Neuroticism which are two of the Big Five Personality traits, and positively associated with Extroversion, also another of the Big Five traits (Abood et al., 2020). Just as an inefficacious person doubts their abilities with regards to the successful performance of tasks, an individual with IS is doubtful of their competence in performing a task. Therefore, following the attainment of their goals, they are unable to internalize this achievement and would rather attribute it to hard work and /or luck.

Relationship Between Impostor Syndrome and Self-Efficacy

The three dimensions of IS delineated by Clance and Imes (1978) are doubts about one's capabilities (SE), inability to internalize success (IS), and the attribution of one's accomplishments to chance (IS). This explanation of IS supports the claim that IS and SE are associated in some way. Tarieh (2021) in their assessment of the relationship between IS and SE found a negative relationship between the concepts, which means that the lower an individual's SE, the more likely they are to develop IS. Gottlieb et al. (2020) postulated that IS is likely to impact a person's SE as well as their potential success. Surprisingly, we found one study that discovered the concepts to be positively linked, with 91% of the self-efficacious students attributing their successful performance to other factors but not themselves (Yamini and Mandanizadeh, 2011). A positive connection indicates that the higher a person's level of S-SE the more likely they are to exhibit STEM IS. This finding may be an inaccurate report or an artifact of data collection because IS refers to a negative self-perception and SE is also concerned with self-belief. It seems more logical for any extant relationship between them to be the opposite (negative) since SE is considered a negative psychological state when it's low and a positive one when it's high, therefore when SE is low, there should be an increase in IS, thus indicating there is a negative relationship.

Proposed Study

The Social Cognitive Career Theory suggests that S-SE influences the career choices that students make. It is imperative that students are encouraged to be efficacious in their STEM capabilities because this is essential to their interest and perseverance in pursuing STEM careers. Teachers and students both can play an active role in increasing students' S-SE and reducing STEM IS. To this end, a qualitative study was conducted to illuminate the prevalence of STEM IS among adolescent learners through an exploration of STEM IS and S-SE from a teacher's perspective. The in-depth interviews will contribute to scarce literature on STEM IS and S-SE. Analysis was guided by the following research questions:

Research Questions

1. In what ways do teachers see IS manifest in the classroom?
   1a. What are the implications for their interactions with students?
2. How do teachers perceive the connection between STEM IS and S-SE?

METHODS

Qualitative

Participants

We reached out to K-12 teachers via email to request their inclusion in our study. They were recruited from Washington State University. Our participant from Guam was an elementary school science teacher with six years of experience teaching in public schools. Teacher from Central America taught first to fourth grade with three years of private school experience, while teacher from North America taught elementary school with ten years of private school experience. They each consented to participate in three separate 30-minute interview sessions conducted via Zoom within one week. All three identified as female. The diversity in our interview sample was a strength of this study.

Interview questions

Participants were asked questions in relation to their perceptions about the prevalence of STEM IS and S-SE among students in their STEM class. Examples of questions were *"In what ways do you perceive a connection between students' S-SE and STEM IS? In what ways do you think students' beliefs about their STEM capabilities is related to their future career interests? What role did your perceived S-SE as an early adolescent have in your decision to teach STEM in school?"*

Analysis

We employed an inductive approach in order to generate themes from the participants' responses. Memos were written during the interview discussions. Participants were not given access to the questions prior to conducting the interview but we ensured that they were cognizant of the concept of IS and SE in STEM. With participants' permission, all interviews were recorded for transcription purposes and deleted immediately after this was concluded. The coding process adopted the use of reflexive analysis which has been described as the method of thematic analysis involving the researcher's own interpretation and identification of specific patterns as well as the conceptualization of themes (Braun and Clarke, 2019).

Following each interview, the researcher worked on reflexively coding and thematically analyzing responses in order to determine the teacher's viewpoint regarding the prevalence of STEM IS, and the ways in which STEM IS and S-SE work together to influence the learner's self-perceptions and their career interests. During the reflexive coding process the researcher's positionality was acknowledged and considered. It should be noted that the researcher is a scholar who struggled with feelings of STEM IS and low S-SE as an adolescent. Specifically, she is a bilingual Educational Psychology master's student who grew up in Ghana, West Africa in a family with divorced parents. The researcher is currently an international student who as at the time this study was being conducted, had lived in the United States for seven months. It is imperative to state the researcher's positionality as an international student who experienced STEM IS as an adolescent, as this experience could have influenced the types of questions the teachers were asked, and may have swayed the discussion to generate more responses about the STEM IS prevalence.

RESULTS

Findings

Findings from interviews with a science teacher, a math teacher, and a general education teacher generated an in-depth understanding of the manifestation of STEM IS and S-SE in the classroom. These interviews allowed us to gain further insight into teachers' viewpoints regarding students' STEM IS, S-SE and STEM careers, as well as provide possible explanations for students' aversion to STEM subjects (Kopparla and Saini, 2022). Developed with the use of thematic analysis, the findings from this study are categorized into five distinctive themes (Braun and Clarke, 2006). They include the following: *Inversely proportional relationship, Intense cognitive effort requirement, STEM intelligence narrative, S-SE contributes to motivation, and S-SE influences career decision.*

Inversely proportional relationship

Information gathered from the interviews regarding teachers' perceptions about the topics showed that they perceive students' STEM IS to be impacted by their S-SE. The theme "inversely proportional relationship" was how the teachers described the ways in which students' beliefs about their STEM capabilities are affiliated with their own perception of their science or math intelligence. An inversely proportional relationship between STEM IS and S-SE indicates that the higher a student's S-SE, the less likely they are to harbor STEM IS. To put it another way, a learner's doubt about their STEM abilities can influence their self-perception about the role their intelligence played following a successful task completion. Specifically, one participant – a math teacher, stated that students may believe "if I can actually do this then I'm a science person. If not then it's not for me". They also elucidated that this thought pattern was not always the same among all students and provided examples of students who were confident in their cognitive ability to perform but yet doubted they were intelligent enough to be consistent. Another crucial finding from this math teacher was that "IS tends to be less when students actually have a firm understanding of the math topics we learn". This emphasized the inversely proportional ways in which teachers believe STEM IS and S-SE manifest together in STEM learning among adolescent learners.

Intense cognitive effort requirement

Findings from the interviews with teachers in some way echoed the sentiments expressed in the literature by Funk and Parker (2018), thereby shaping and reinforcing our problem statement regarding students' avoidance of

STEM fields due to their perceived difficulty. When asked about the reason for their students' aversion to STEM learning and engagement, they discussed how students dislike the "difficulty of math learning", as well as the "cognitive effort and dedication" that is required for the mastery of STEM subjects.

A particularly noteworthy discovery was made by the general education teacher who observed that students often developed a dislike for math or science based on the interests of the parent they identified with the most. These students, having witnessed their parents' struggles in these subjects, eventually resigned themselves to the belief that they were incapable of learning math or science. This knowledge further solidified their negative perception and contributed to their low SE in math or science, while also influencing their sense of belonging in the field. Feeling like they didn't belong became a significant characteristic of their experience, aligning with the concept of IS. In conclusion, the findings strongly suggest that adolescent learners' aversion to STEM subjects, particularly math and science, stems from the perceived difficulty in comprehending and mastering these subjects.

STEM intelligence narrative

The theme of the STEM intelligence narrative developed from discussions which reflected the idea about STEM learning and potential STEM careers as being suitable only for precocious learners who possess innate STEM capabilities. One math teacher disclosed that "the narrative about STEM influences STEM career interests". They elaborated on the narrative and/or misconception their students have about careers such as astronomical engineering, mathematician, scientist, as being attainable solely for those with "inherent 21st-century skills". Students with low S-SE do not show interest in STEM careers when they do not believe they possess the cognitive skills to excel in them. According to one teacher, students tend to show interest in STEM careers when they are in elementary school and wish to become an astronaut for instance, but that "interest begins to decline as they advance into higher grades and fail to develop mastery skills in the science and math subjects needed for those careers". The failure to develop the mastery experience needed for the sustenance of those STEM career goals and interests leads to a low S-SE and the eventual disinterest in a STEM career.

S-SE contributes to motivation

When asked about the differences they observed between students who exhibited a higher level of S-SE and students who were not efficacious in STEM learning, the common theme was "motivation". Speaking from their individual experiences with adolescent learners, they recalled those with a lower S-SE having a significant lack of motivation to engage with the "math, science, and technology-related subjects I taught in general education". Whereas students who possess confidence in their cognitive ability to perform well view learning tasks as "challenges", learners who have doubts about their cognitive abilities, view those tasks as "threats". An important finding was that those with low SE in STEM learning would always be more concerned with their grades and performance than the actual comprehension of the subjects. This is an implication that such learners with low S-SE were performance-oriented whereas those with a high S-SE were mastery-oriented.

S-SE influences career choice

Finally, as an overarching theme, teachers emphasized the role of learners' S-SE in their career choices. This discussion took the retrospective route with teachers reflecting on their own experiences and the ways in which their S-SE impacted their career choice. All teachers agreed that their S-SE in middle school and through higher education is the reason they chose to teach "math" and "science" subjects. One teacher for instance, established that their love for science was somewhat innate, but was also fortified by the encouragement from teachers in support of their ability to engage with the science topics taught in class. The only reason this teacher chose to teach Biology instead of study medicine as was the initial plan was because they were unable to handle the sight of blood; "teaching science was a close second and I'm glad I get to teach a subject I'm great at". "My mother was a math teacher, and I grew up loving math as well as having straight As in it" was the response from another one of the teachers we interviewed. Participants who mentioned having a high S-SE, confirmed that they never experienced any feelings of STEM IS possibly because they were thoroughly intrigued with the subject and their belongingness was confirmed by excellent academic performance. From an early age in elementary school, they knew their math performance was exemplary and thus their SE in the subject was high. They reported never struggling with IS in math learning, possibly due to their high SE in the subject as well as the influence from their mother who also taught math. This high SE in math served as a catalyst for their future participation in several math competitions. The choice to teach math was based on their love for tutoring others in a subject they perceived themselves to be cognitively equipped enough in to teach.

Teacher's interaction with students with STEM IS

Now, in response to the research question regarding teacher's interaction with students who exhibited signs of STEM IS, two out of three teachers recalled having a fairly more difficult time working with such students in comparison with students who show no signs of STEM IS. Although one teacher admitted to not taking any notice of STEM IS among their students, the other two spoke on their own teaching and learning experiences. According to one participant, "I had one student who hardly ever had good grades in my class, so much so that the few times she actually scored a high grade, she thought I was just being lenient because I felt sorry for her. I was never able to convince her otherwise". Another professed that students seem to retreat into their shells and become avoidant while class is in session. Activities that involve active interaction and learning with other students is met with resistance because students are embarrassed about being potentially unable to perform as well as their peers. According to one teacher, this fear stifles their "productivity and participation in class" while making it wearisome and taxing for the teacher to provide them with the obviously needed assistance. "The teacher can only do so much. It can get a bit frustrating. I noticed that some students are so firmly set in their negative perception of themselves that they stop trying".

DISCUSSION

STEM education is essential for the preparation of competent workers in order to fulfil the 21st-century demand for collaborative, communicative, and innovative critical thinkers who are to become experts in STEM fields (Widya et al., 2019). In recent times there has been a significant increase in the demand for workers that are proficient in science, math, technology, and engineering, but the supply has not been sufficient in meeting this demand (Jang 2016; Wang and Degol, 2016). The study of STEM IS is scarce, and its association with S-SE has yet to be meticulously explored and discussed among adolescent learners or with educators. The purpose and rationale of this study was to explore the manifestation, career and academic implications of STEM IS from a teacher's perspective. This will be helpful in providing further insight into possible reasons for the sparse supply of a competitive STEM workforce to meet the escalating demand (Jang 2016; Wang and Degol, 2016). In the current study we substantially focused on the connection between STEM IS and S-SE and also discussed the concepts of STEM IS and S-SE with teachers to gain insight into if and how these conceptions manifest in the classroom.

Presence of STEM Impostor Syndrome

The first goal of this study was to assess the prevalence of STEM IS among adolescent learners. As previous analogous studies on IS in adolescents (Chayer and Bouffard, 2010; Tarieh, 2021) have stated, although it may be with less intensity, early adolescents are prone to Impostorism. To our knowledge, hardly any studies have identified the presence of STEM IS among early adolescents in school.

The findings identified the prevalence of STEM IS in adolescent learners based on teacher's reports. This is in support of our primary research question which sought to explore the manifestation of STEM IS among adolescents. The results suggest that adolescent learners who have doubts about their competence in their successful performance of STEM tasks (Bandura, 1977) tend to also harbor uncertainties regarding the significant role of their own intelligence in accomplishing those tasks. This finding is in accordance with similar studies (Tarieh, 2021) that described in their assessment of the relationship between IS and SE a negative relationship between STEM IS and S-SE. This suggests that the lower an individual's SE, the more likely they are to develop IS.

Interviews with teachers

Discussions with the K-12 STEM teachers afforded us the opportunity to explore STEM IS from a teacher's perspective, while also giving us insight into the ways in which it manifests in their respective classrooms. In response to our first qualitative research question, teachers' perceptions of the ways in which STEM IS has evinced among students in their classroom was discussed. Findings suggest that students with low S-SE tend to avoid participating in group assignments or activities because of the fear of being discovered as unintelligent. This finding supports another which found that individuals struggling with IS in a field or subject have such beliefs of inadequacy that they tend to avoid situations of perceived failure (Enget et al., 2020). As mentioned at the beginning of this study, individuals with IS struggle with the anxiety of being exposed as intellectually disingenuous – a significant characteristic of the seemingly innocuous and almost trivial IS. Teachers reflected on their career choices as being unequivocally influenced by self-perceptions regarding their STEM capabilities as well as their belongingness in the field.

With regards to our question about the connection between STEM IS and S-SE, our finding suggests that teachers perceive that STEM IS and S-SE jointly influence students' behavior and interaction with STEM subjects and potential STEM careers. This study's findings are in support of Tarieh (2021) who reported that the more a student doubts their STEM capabilities, the more anxious they are about being discovered as intellectual frauds. When students have a firm grasp and comprehension of the topics they learn, and when they are able to challenge their cognitive abilities in studying these subjects, they are less likely to show signs of Impostorism in this domain. Participants provided examples of students who doubted their cognitive math abilities regardless of their good grades. In some way this reiterates the viewpoint of another participant who stated that students show signs of STEM IS when they have not yet mastered that particular STEM subject because they have only been concerned with their performance.

Limitations

The perspective-based nature of the study as well as the qualitative method it employs complicates its replication by other researchers. This denies us the ability to support the defense of its reliability for the purpose of increasing confidence in the merit of our results. Suffice it to say the results of this study may be subjective and may not be generalizable to the average STEM teacher's classroom experience, as well as that of the average adolescent student. Secondly, while the teachers in this study provided insight into how STEM IS is experienced by STEM learners, the study did not investigate the specific teaching strategies that participants may have utilized in the past to enhance their students' S-SE. To gain a deeper understanding of effective teaching methods in STEM education, it is recommended that future studies explore teachers' personal experiences and testimonies regarding the implementation of various successful teaching strategies.

CONCLUSION

In order to understand the factors that contribute to students' general disinterest in STEM careers (Funk and Parker, 2018), it helps to delve into the concept of mental states and self-perceptions. This is what inspired the study of STEM IS and S-SE among adolescents. In our study, we found that an individual's mental state (Clance and Imes, 1978) and self-perceived ability to learn can influence adolescent STEM learning. Therefore, it is vital that adolescent STEM learners are supported early in their engagement with STEM subjects.

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