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THE ROLE OF STEM ENRICHMENT ON COURSE TAKING AND ACADEMIC PERFORMANCE FOR HIGH SCHOOL STUDENTS WITH DISABILITIES

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ABSTRACT

THE ROLE OF STEM ENRICHMENT ON COURSE TAKING AND ACADEMIC PERFORMANCE FOR HIGH SCHOOL STUDENTS WITH DISABILITIES

Momodu Sesay

The demand for science, technology, engineering, and mathematics (STEM) courses in education aligns with the need to advance society through innovation and research. Proficiency in STEM courses and curriculum is critical for nations to become global economic leaders. However, the majority of students in high school do not participate in STEM programs due to barriers to access and inclusion in these programs, particularly for underrepresented groups inferred to Students with disabilities (SWDs). The current study uses secondary data with a study population of 20,000 students from the High School Longitudinal Study of 2009 (HSLS, 2009) to analyze the relationship between the independent variable (STEM enrichment program), as well as the dependent variables (math scores, number of STEM courses, and number of high school attendants). Overall, 8.2% of students responded as having a disability that affected their ability to succeed in STEM programs, while 91.8% indicated they had no disabilities. A bi-plots between STEM enrichment versus math scores, the total number of stem credits, and college attendants of students with disabilities and non-disabled were explored to see if the increased STEM enrichment programs significantly affected student math scores. The results showed that student math scores and the number of STEM credits generally increase as the number of STEM enrichment program offerings increases for disabled students. There is no significant relationship between STEM enrichment programs and the number of

college attendants, however, because disabled students go to college for other courses in addition to taking STEM enrichment programs. Although STEM enrichment programs may offer useful experiences and skills, these programs—which frequently target high school students—might not address structural challenges students with disabilities have when trying to attend higher education. Results also showed that an increase in STEM enrichment programs has little effect on both student math scores and the number of college STEM credits taken by non-disabled students. Prioritizing STEM course offerings for students who are disabled, focusing on educational programs and policymaking, could potentially impact student performance in math for both students who are disabled and students who are not.

DEDICATION

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my wife Saffie and daughters; Mabinty, Kaday, Rugiatu, and Marion whose words of encouragement pushed for tenacity ringing in my ears. My dad and mom of blessed memories and to all my brothers and sisters.

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CHAPTER 1 INTRODUCTION

The demand for science, technology, engineering, and mathematics (STEM) courses in education aligns with the need to advance society through innovation and research. STEM courses provide individuals with a significant knowledge base that equips them to tackle and resolve many critical issues in 21st-century society (Hwang & Taylor, 2016). Proficiency in STEM courses and curriculum is critical for nations to become global economic leaders. Moreover, access to a quality STEM curriculum can enhance educational outcomes and translate into a higher quality of life in terms of greater competitiveness for often high-paying jobs for those who complete these programs (Hwang & Taylor, 2016). However, not all students can complete their studies in STEM due to barriers to access and inclusion in these programs, particularly for underrepresented groups in the United States (Gregg et al., 2016). Students with disabilities (SWDs), representing one underrepresented group, often face two key barriers that can interfere with their access and/or ability to complete STEM programs of study. The barriers include poor retention/participation and low grades in STEM courses, leading to lower student graduation rates in STEM programs (Bellman et al., 2015).

Educational institutions are experiencing greater diversity of learners, which requires a greater effort toward inclusivity (Gregg et al., 2016; Schreffler et al., 2019). Not making efforts of inclusivity in STEM education can alienate diverse learners. For example, SWDs who do not see STEM programming that is inclusive of their needs can avoid STEM majors or leave soon after joining a program, contributing to low participation and graduation rates in STEM for SWDs. Doing so can also lead to negative attitudes toward these courses that translate into poor attainment of adequate proficiency at a national level (Hwang & Taylor, 2016). Indeed, not all students who intend to major in STEM fields complete their degrees, particularly for SWDs (Schreffler et al., 2019). A low completion rate for SWDs is problematic for addressing the inclusiveness of STEM programs. It highlights a need to understand the learning opportunities/programs that can effectively promote the growth and development of SWDs in STEM courses programs of study.

Establishing structures within an educational system that can effectively promote diverse student performance requires the re-conceptualization of STEM education needs. This inquiry is pertinent to understanding some programs that can effectively increase retention among SWDs in STEM courses. Incorporating strategies to actively support and encourage SWDs to participant and complete STEM programming can help to increase the interest, participation, and retention of SWDs through graduation (Kolne & Lindsay, 2020). Addressing the need for inclusiveness for SWDs will require deliverables such as increasing retention rates and participation in STEM courses among these students through graduation and tracking progress so these efforts can continue to improve and grow and the diversity in these programs grow (Schreffler et al., 2019).

Learning opportunities for SWDs are essential to provide achievable outcomes for these students in STEM careers. Barriers identified for SWDs pursuing STEM careers include a lack of encouragement to pursue STEM, language proficiency needs, and difficulties completing the STEM programs (Dunn et al., 2018). The nature of the current issue underscores the gap in support services that could otherwise significantly reduce the barriers experienced by SWDs in STEM fields. Some support services that can reduce the barriers they experience include virtual mentoring, social networking, preparation of instructors, and social networking (Dunn et al., 2018).

Therefore, educational institutions need to develop initiatives to better prepare and support students in these subjects for their current and future needs. These initiatives can increase STEM enrollment and retention, particularly among underrepresented groups.

Research demonstrates that diverse learners can become talented professionals within the STEM fields. There is a need to create support systems that would help SWDs successfully register and complete their STEM courses (Street et al., 2012). Thurston et al. (2017) also pointed at several possible challenges that need to be addressed. Addressing the challenges can help explain why many SWDs are underprepared for postsecondary coursework at the university level. One key challenge that needs to be addressed is the level of the academic curricula when it comes to science and math, especially in special education classrooms (Thurston et al., 2017). There is a lack of understanding, cooperation, and a reluctance to enroll SWDs among 9^{th} to 11^{th} grade students. Lisberg and Woods (2018) proposed a more integrative approach that offers mentorship and learning strategies within the STEM fields intending to increase retention and acceptance of SWDs in STEM-related fields (Lisberg & Woods, 2018).

To help address the lack of adaptive aids and the inadequate availability of resources to support the learning needs of SWDs in STEM fields, Lynch et al. (2017) proposed enhancing inclusiveness in the classroom and having an organized and mission-driven administrative structure in STEM programs (Lynch et al., 2017). These solutions were proposed to address the numerous challenges facing SWDs within the STEM fields, although substantive gaps remain in addressing concerns for SWDs. As a result, Bellman et al. (2015) recommend that future research focus on evaluating solutions for SWDs in STEM fields with various disabilities. Further suggestions for evaluating solutions could include utilizing control groups and comparing reported gains and academic successes based on the type of disability, both pre-and post-measures (Bellman et al., 2015). These suggestions support the empirical and theoretical needs to evaluate various programs and measures that can improve learning among SWDs in STEM courses.

Statement of the Problem

The problem to be addressed in this study is to understand better the effects of supplementary classes and STEM enrichment programs on the participation and learning outcomes for high school students with disabilities (SWDs) in STEM courses (Lee, 2020; Scheffler et al., 2019). SWDs face challenges in completing STEM courses. The application of education programs designed for these students can play an immense role in creating the desired inspiration and engagement level to ensure successful completion of the courses after enrollment for the stem programs. Some barriers make it difficult for SWDs to complete their studies in STEM, including struggling with class sizes, the fast-paced learning environment, inadequate scaffolding for the curriculum, poor content precision, and the rigid pedagogy of the STEM faculty (Scheffler et al., 2019). Conventional education reforms look at the system-level changes primarily focused on instructor behaviors and support systems, which do not otherwise substantially impact the attrition rate for STEM majors.

Even as the number of SWDs rises and the diversity of the learners increases, these students continue to underperform in STEM courses. An educational system that promotes better student performance requires the re-conceptualization of learning/teaching methods that recognize that students with learning disabilities lag compared to their peers (Hwang & Taylor, 2016). One example of this method is the universal learning design, a STEM curriculum designed specifically for SWDs. This curriculum demonstrates the value of implementing support systems and educational resources to strengthen retention rates for SWDs in STEM courses and programs. Comprehensive research into this subject was critical in scaling social mobility and equity issues for SWDs enrolled in STEM courses (Lynch et al., 2017).

Purpose of the Study

The current quantitative study aims to examine the extent to which STEM enrichment can increase participation in STEM courses and improve learning outcomes for students with disabilities (SWDs). As a result, this study investigates how SWDs are likely to participate in STEM-related courses and determines how participation in STEM support systems affects learning outcomes, especially for SWDs. Understanding the needs of SWDs plays an essential role in creating support systems that effectively promote learning and participation among SWDs in STEM courses (Williams et al., 2015). The main goal is to identify support systems that can address the challenges facing SWDs in STEM courses.

Conceptual Framework

The conceptual framework adopted for this study uses a modified version of Weaver-Hightower's (2008) ecology metaphor of learning environments. Relating the classroom to the ecological connections and interactions that organisms have with one another and their physical surroundings highlights the dynamic nature of learning environments. The ecology of a classroom helps address learning environments as functional systems with three major elements: actors (relates to the organisms in the metaphor), actions (relates to the connections or interactions of organisms in the metaphor), and contextual factors (relates to the physical surroundings in the metaphor)—all of which work interdependently (Erdogan & Stuessy, 2015). As with natural systems in which living organisms interact, the actors within the school learning elements tend to interact among themselves. One example is where students and teachers interact to achieve a unified goal. Additionally, contextual factors such as boundaries are defined as the facets of educational ecosystems in which the previously mentioned actors perform their actions. Finally, the steps in educational ecosystems entail cooperation, a transferable component in understanding the complex interactions between the actors (Erdogan & Stuessy, 2015).

These three elements serve as the core constructs of this study, whereby my research assesses each construct and its impact on STEM courses among SWDs using existing archival data. For this framework, the students with disabilities serve as the primary actors, whereas the teachers, administrators, and other actors support student development (Erdogan & Stuessy, 2015). When students are placed at the center of the school ecology, it generates a learner-centered school that helps provide students, especially SWDs, with the most genuine opportunities to ask questions and find solutions under the teacher supervision. Another factor that the framework suggests is the influence of role models, who are not limited to faculty members, technicians, business industry leaders, and other STEM professionals (Erdogan & Stuessy, 2015). Role models can present a motivational factor and guidance for the SWDs undertaking STEM courses, including the teachers in charge of disseminating knowledge. Role models can interact with students and teachers through various programs regardless of the school boundaries. Such an immersion can help maintain SWDs undertaking STEM courses and keep their interest as high as possible (Erdogan & Stuessy, 2015).

The second construct addresses contextual factors within the school ecology framework. These can be summarized as the learning environment (Erdogan & Stuessy, 2015). This construct can ultimately help educators identify better solutions for improving the participation of SWDs in STEM courses. The contextual factors revolve around the current challenges faced within STEM courses, including their lack of preparation, lack of understanding and cooperation from administrators, faculty members, and relevant staff, unavailability of suitable adaptive aids, presence of inaccessible buildings and grounds, and a lack of other necessary accommodations for SWDs that can otherwise promote their success in STEM courses.

The third construct touches on collaborative actions within a school ecosystem. Some collaborative steps involve teaching, learning, immersion, communication, partnering, mentoring, support, and assessment (Erdogan & Stuessy, 2015). The framework proposes cooperation and symbiosis among the relevant actors rather than through competition and predation. An excellent example of collaborative actions is the Mastery Peer-Led Team Learning approach, an integrative approach offering mentorship. The approach integrates mindset and learning strategies in STEM fields, supports social mobility, addresses equity gaps for SWDs taking STEM courses, and is an organized and mission-driven administrative structure (Erdogan & Stuessy, 2015).

Evaluation and monitoring are a final construct that was added as a modification of the school ecology framework already outlined. The posed challenges for SWDs in STEM courses, in turn, serve as the indicators that provide adequate information about the program and system's state, as well as progress toward expected outcomes (Kioupi & Voulvoulis, 2019). Addressing challenges that SWDs face serves to advance progress toward achieving a more inclusive learning environment for SWDs in STEM fields. The educational framework proposed by Kioupi and Voulvoulis (2019) has improved the whole-institution approach targeting education, research, operations, and administration. These areas where learning and training have been aligned help ensure the sustainability and accountability of educational programs to provide an inclusive learning environment (Kioupi & Voulvoulis, 2019).

STEM Enrichment

Disability rights supporters emphasize that, as contemporary society evolves, terminology about disability that perpetuates an image of pain, pity, and reliance–for example, crippling or handicap–may have to be addressed. The phrase ‘people with disabilities’ was added in adopting the ADA, which would be regarded as ‘people-first’ language in the legal world. Disability activists refer to people with disabilities using People-First Language (PFL). Placing the person first, enabling people to decouple the handicap as the major distinguishing trait of an individual, and perceiving disability as one of the numerous qualities of the full person are all attempts to use PFL. Aiming to change perceptions of disability in a culture that considers it degrading, activists wanted others to understand that ‘having a handicap does not diminish your humanity.’

Furthermore, since racial minorities have traditionally been undervalued in scientific graduate degrees, which are generally a prerequisite for high-paying technical employment in STEM-related sectors, an extremely diversified U.S. population might have a negative impact on STEM leadership. According to the National Center for Education Statistics, Black and Latino students comprised 15 and 13 percent of undergraduate students in 2009, but only 12 and 6 percent of post-graduate learners, correspondingly. In accomplishing graduate degrees, Black and Latino educators accounted for only 7.6 percent of all doctoral degree beneficiaries through core STEM disciplines such as engineering, physical sciences, and mathematics in 2009, according to the National Center for Education Statistics. Given that Black and Latino Americans are expected to account for more than 40% of the population of the United States by 2045, it is critical to increase participation in STEM fields and enhance STEM outcomes among all these students to make sure that the country has several competent scientists to meet demand.

Research Questions

The following research questions guided the study:

1. Do SWDs who attend high schools with more STEM enrichment programs have higher math scores than SWDs from schools with fewer STEM enrichment programs?
2. Do SWDS who attended high schools with more STEM enrichment programs take more STEM course in high school?
3. Are SWDs who attend schools with more STEM enrichment programs more likely to attend college?

Hypotheses

The following corresponding hypotheses guided the study:

H1: The implementation of STEM enrichment programs at high schools increases the math scores of SWDs compared to schools that do not implement these programs.

H2: Taking STEM courses in a high school are associated with SWDS attending high school.

H3: Attending College by SWDS is associated with those who attended schools with more STEM enrichment.

Significance of the Study

The significance of this study is that it explored some of the learning programs or approaches that can be used to help students with disabilities complete STEM courses. Importantly, this study can address barriers to STEM education among SWDs through a strengthened understanding of the curriculum needed for skill development and advocacy on STEM programs. The research outcomes would further provide a basis for advocating for effective learning practices and circumventing barriers that hinder the access and inclusivity needed to support SWDs enrolled for STEM courses effectively. The theoretical framework extends and incorporates the key instructional components that can stimulate the learning process among students pursuing STEM courses with varying difficulties. The study includes multimodal representations to allow students to experience knowledge development in a supportive environment. Such research processes emphasize the development of an inclusive integrative education framework that increases the chances of success for students with disabilities.

The findings in this research study are beneficial for students, educators, and administrators because they provide a framework to demonstrate how STEM education can be advanced for SWDs. The framework identified includes paying particular attention to problem-solving skills, increasing hands-on learning experiences, and promoting student motivation through an integrative learning model. The key beneficial outcomes addressed include facilitating content knowledge and skills to help SWDs attain equitable opportunities while undertaking STEM courses. The study focuses on the diverse needs of SWDs by identifying interventions and modifications to promote an inclusive learning environment for all students.

Questions of access and equality in education are frequently addressed and handled concerning conceptions of diversity and inclusivity. Students with disabilities were recruited and retained by an equitable and accessible university that would attract and keep a broad population of students. Higher education has made a significant effort to encourage and support diversity in recent years. To boost diversity, universities have implemented various strategies, such as appointing a senior-level diversity officer or establishing an office for inclusiveness to improve the recruitment and retention of students with learning disabilities. Students with disabilities continue to be underrepresented in higher education despite the efforts of institutions to improve diversity. Data on enrollment, persistence, and achievement reveal this is still the case.

Furthermore, this underrepresentation throughout higher education is evident in the domains of science and technology and engineering and mathematics (STEM). Today, 12 percent of the United States population has (identifies with) a handicap. These patterns, particularly in STEM professions, are not reflected in the numbers of people employed in these sectors. Now, persons with impairments account for barely 2 percent of STEM experts in the field. Students enrolled in postsecondary education receive the same treatment of lack of representation as those enrolled in higher schooling: 9 percent of the population of students enrolled in undergraduate STEM fields, 5 percent enrolled through graduate STEM programs, and much less than 1 percent enrolled in doctoral programs. It is necessary to develop venues that are accessible and fair to a diverse student population, which includes students with disabilities, to boost diversity in STEM areas (SWDs). SWDs bring a variety of viewpoints to the table that are critical for cutting-edge STEM research. As part of this variety, there is a wide range of talents and limitations. The STEM profession must provide chances for all students to achieve and engage regardless of their abilities.

Introduction to Research Methodology and Design

The research methodology used in the study is a quantitative archival research design, using the High School Longitudinal Study of 2009 (HSLS, 2009). The use of archived data as an approach in this study was critical to identify data related to education and learning outcomes for SWDs. Using archived data in this way entails collecting and synthesizing data from publicly available databases. The rationale behind this approach is to create a platform that played a role in advancing knowledge and facilitates the development of the theory into the subject (Snyder, 2019).

The research methodology takes a quantitative approach (Snyder, 2019). The study approach was critical to better understanding the potential barriers that hinder the successful completion of STEM courses among SWDs. A component of this research methodology involved using archived data from publicly available data sources to identify quantitative data related to outcomes for SWDs in STEM fields of study.

The data was analyzed using SPSS. Projected key outcomes following data analysis were to identify data related to outcomes for SWDs in STEM fields of study that advance their success in STEM courses. The data analysis played an important role when embedding the outcomes into the theoretical framework outlined. The research design and methodology are based on identifying relevant data sources to systematically and comprehensively analyze data that can inform outcomes for SWDs in STEM fields related to the theoretical framework identified.

Definitions of Terms

Postsecondary education, also called tertiary education, is the education that follows the successful completion of secondary education. This type of education culminates with the award of a diploma, and certification of an academic degree (Unangst, 2017).

Science, Technology, Engineering, and Mathematics (STEM) is an abbreviation of closely related fields, including science, technology, engineering, and mathematics (Reinking & Martin, 2018).

Students with disabilities (SWDs) have some physical or mental impairment that substantially limits one or more aspects of their life (Vanderbilt University, 2018).

Universal Design for Learning is a way of thinking about instruction, teaching, and learning that helps a diverse group of students achieves a level playing field by offering an equal opportunity to succeed (Schreffler et al., 2019).

Summary

The current demand for STEM professionals has seen a surge in students enrolling in these courses. Proficiency and attainment of the curriculum in STEM courses pose a challenge for SWDs despite the promise of better career opportunities. As institutions of learning continue to experience enriched diversity in the classroom, ensuring no one is left behind when it comes to enrolment and completion of the studies is essential. Identifying and implementing support systems for these students was critical to enhancing learning and participation for SWDs. The current quantitative study aims to evaluate the extent to which STEM enrichment programs can increase participation in STEM courses and improve learning outcomes for students with disabilities (SWDs). Understanding the unique needs of these students was critical to creating the support systems needed to support these students. A quantitative research methodology formed the basis of inquiry to collect and synthesize the data. The research outcome entailed bridging the knowledge gap and creating a discourse to help SWDs overcome the barriers to learning and the successful completion of STEM courses and programs through an interdisciplinary framework. The knowledge derived from the study helped address the interventions needed for educational institutions to effectively facilitate learning opportunities for SWDs undertaking STEM courses and curricula.

CHAPTER 2 LITERATURE REVIEW

A key concern, specifically for continuously improving evidence-based STEM education, is expanding the access SWDs have in this field and the preparation educators must teach these students. Advancing the competencies among SWDs in STEM fields is critical toward strengthening the diversity of education. Focusing on this integration requires a framework to operationalize STEM adoption and learning. As Kelly and Knowles (2016) noted, there is an urgency to improve educational outcomes in STEM courses. A status report for students in grades 9 (high schoolers) recognizes that some challenges include competing agendas, lacking coherence, and lacking a basic understanding of the critical teaching intersections for STEM integration. The prospect of integration is essential when creating a platform that can reach the diverse needs of learners. Quality education in STEM underscores the importance of preparing SWDs to build their knowledge and literacy of the core STEM subjects. The following section reviews and organizes the literature related to the research topic by topic/subtopic.

Introduction to Theoretical and Conceptual Framework

The conceptual framework chosen for the study is Weaver-Hightower's ecology metaphor used for the learning environments. The framework focuses on learning environments as systems comprising actors, contextual factors, and actions, all working interdependently. These three constructs constitute a skeletal structure for the specialized STEM schools outlined by Eisenhart (1991).

The first construct focuses on the actors who, within a given ecosystem, play individual roles while also depending on others. As indicated earlier in an outline of the framework, the actors include students, teachers, and role models (Erdogan & Stuessy, 2015). The students are the primary actors in this framework, whereas the teachers, administrators, and role models support the development of the students. A learner-centered school can be developed with a framework that can provide students with opportunities to ask questions and find solutions under their teachers' supervision (Erdogan & Stuessy, 2015). The research would suggest that students can pose questions, make observations, collect data, interpret data, take risks, test conclusions, and become creative in such an environment. The teachers in such an environment tend to be more flexible in tolerating their students' mistakes after taking advantage of these opportunities.

Well-trained teachers in specialized STEM schools should master domain and instruction strategies, dedicate themselves to teaching, facilitate learning, challenge students, utilize technology effectively in the classroom, and become school leaders (Erdogan & Stuessy, 2015). Teachers must be allowed to update their knowledge and skills by attending professional development workshops.

Finally, the role models/mentors within the framework include university faculty members, technicians, business and industry leaders, STEM professionals, and parents (Erdogan & Stuessy, 2015). The mentors represent a motivational factor and guidance for the students and the teachers. The mentors can interact with the students and teachers through internship programs regardless of the school boundaries (Erdogan & Stuessy, 2015). Immersing students into real-life experiences through internship/apprenticeship with their mentors effectively implements what they learn in classrooms. Immersion can also be beneficial in maintaining the interest of SWDs in STEM and keeping this motivation as high as possible.

The second construct addresses contextual factors within the school ecology framework. These can be summarized as the learning environment (Erdogan &

Stuessy, 2015). The construct can ultimately help educators identify better solutions for improving the learning outcomes and participation of SWDs in STEM courses.

Other contextual factors within the framework entail rigorous curriculums and instructional strategies. Setting high standards alone cannot create desirable changes unless a rigorous curriculum that integrates STEM disciplines accompanies them (Erdogan & Stuessy, 2015). Especially for the SWDs, a rigorous curriculum must prioritize standards, assign standards to specific units, include effective teaching strategies, integrate formative assessment, and provide remediation intervention before each subject. Teaching and learning in STEM disciplines require instructional strategies that give immersion and continuity.

The third construct touches on collaborative actions within a school ecosystem. These are relationships developed between the actors, involving teaching, learning, immersion, communication, partnering, mentoring support, and assessment (Erdogan & Stuessy, 2015). Cooperation and symbiosis among the relevant actors rather than competition and predation have positive outcomes on learning. Through collaborative actions, schools can create a process that envisions and helps generate a participatory vision between all the stakeholders within the education sector (Kioupi & Voulvoulis, 2019). The construct helps relevant educators and education policymakers identify better solutions for improving the learning outcomes and participation of SWDs in STEM courses. Possible adoption of the framework requires a comprehensive understanding of the current challenges SWDs face in STEM courses, including their lack of preparation, lack of knowledge and cooperation from school administrators, and the need for “buy in” among faculty and staff members (Kioupi & Voulvoulis, 2019).

Additionally, this leads to several critical aspects of barriers. SWDs face, such as the unavailability of relevant adaptive aids, the presence of inaccessible buildings and grounds, and a lack of other necessary accommodations are problematic. There is a need for the educational community to define the vision for the SWDs collectively, a move that will require strong collaboration with local civil societies, engaging the learners, educators, and relevant stakeholders (Kioupi & Voulvoulis, 2019). Participation within the education sector has been shown to increase beneficial synergies, establish positive learning environments for all students (SWDs and non-SWDs), and promote a culture of collaboration (Lidstone et al., 2015; Lozano et al., 2017). Indeed, this leads to a greater sense of civic responsibility as a societal norm.

Collaboration during learning follows recommendations given in the context of the flipped classroom environment and other active learning approaches used. Collaborative learning seeks to eliminate the traditional system, contributing to student passivity. Vygotsky (1978) underlines the importance of culture and language in the process of learning. The proposition of Vygotsky follows cooperative learning in which cognitive development and learned skills come from social interaction. Students with disabilities can benefit mainly from constructivism by gaining upper-level skills through interaction with peers and tutors. Although some of these skills are cultural, they are critical to internalizing the learned concepts. The internalization would be critical in enhancing the success since Vygotsky underscores the individual experiencing thought, behavior, and attitude in the social environment as cognitively functional.

The fourth and final construct adds to the ecological school conceptual framework that involves tracking progress. Following the implementation of support systems to enhance learning and knowledge retention among SWDs, there are enhanced learning outcomes (Kioupi & Voulvoulis, 2019). The participatory framework underscores the importance of outlining the progress and relating it to the expected outcomes. The evaluation and monitoring consider competencies that foster better training and create a learning environment suitable for all students, including SWDs. Importantly, evaluation and monitoring also help understand the effectiveness of approaches and strategies used to meet the learning needs of SWDs in STEM.

The task in the evaluative step is to assess the skills, values, and attitudes that empower students to attain sustainable learning. The relevance of this approach to learning was noted by Sivaraj et al. (2020) in their study, which required employing an integrated STEM strategy to create an authentic learning environment for high school learners. They further noted that students could transfer the importance of learning by applying the knowledge acquired to a human-constructed applied world. The competencies measured included design thinking to help SWDs develop enhanced communication, teamwork, and critical thinking skills (Sivaraj et al., 2020).

The sustainable competencies proposed by Kioupi and Voulvoulis (2019) in the framework are unrelated to cognitive components (knowledge creation and understanding). Instead, they include the thinking abilities which constitute the affective domain of learning. The framework thus targets 'what I learn,' 'what I think,' and 'what I do,' which are essential elements in creating the change in the mindset of learners. The pedagogies that would help make this mindset focus on the cognitive, psychomotor, and affective domains. The three domains are critical in developing sustainable competencies: problem-solving, facilitation of active learning, interpersonal competencies, and systems thinking. Participatory action research focuses on the relationship between the learner and the educator as active partners (Paredes-Chi & Castillo-Burguete, 2018; Parrello et al., 2019). Applying the domains is critical to help the learner experience an authentic learning environment that can further help teams overcome mutual benefits.

Vygotsky's approach supports this perspective through the proposition on the social dimension of consciousness. He asserts that tutors/teachers should not reduce cognition to a psychological process (Bozkurt, 2017). Learners can create meaning through the social interaction of joint activities and consequent internalization, which plays a role in intellectual development provided they are under the supervision of a skilled adult (Bozkurt, 2017).

The theoretical framework that forms the basis of this research is grounded on the aspects of relational, situated, and dependent interactions in the learning environment. Learning STEM among SWDs, constructing meaning, and generating transferrable knowledge is relational (Gevirtz Graduate School of Education, U.C. Santa Barbara, 2017). Interaction repertoires, construction of the discourse, and best practices construct the knowledge and behavioral practices that can inform better learning outcomes. The learner is not just a knowledge receiver but an active problem-solver.

Background on Special Education in the U.S.

Students with learning disabilities (SWDs) require high standards-based quality instruction like their non-disabled peers (Rogers & Johnson, 2018). However, SWDs often either lack the support needed to complete assigned tasks or are not taught by teachers trained to use evidence-based instruction (García-Carrión et al., 2018; Yoro et al., 2020). While determining the level of disability for SWDs is a challenge, these students are guaranteed free and appropriate educational services per code P.L. 94-142 enacted in 1975 (Benitez & Carugno, 2018). Today, all students, including SWDs, must be allowed to make significant annual progress with a special education program mandated under their individualized education program (Browder et al., 2014, 2020). Special emphasis needs to be placed on meeting the unique demands of diverse learners through appropriate interventions, accommodations, and modifications. There are many challenges that SWDs face in their day-to-day activities while completing STEM curriculum (Gokool-Baurhoo & Asghar, 2019) that makes inclusion, learning, and growth of students with various disabilities important to ensure support in their development and success.

In response to the growing diversity of learners, it is important to avail equitable access to quality education, which will help nurture the growth and development of SWDs through special education programs (Gokool-Baurhoo & Asghar, 2019). The Individuals with Disabilities Education Act (IDEA) defines Special Education as the distribution of well-designed instruction to meet the individual and unique needs of all students with disabilities (Individuals with Disabilities Education Act, 2017). Many educators have interpreted special education to mean implementing evidence-based instruction, primarily when this instruction addresses specific student learning needs/skills (Duque et al., 2020). Challenges occur, however, when teachers use evidence-based practice as a one-size-fits-all approach for all students in a class instead of meeting each student's unique and individual needs (Browder et al., 2020; Smale-Jacobse et al., 2019). Therefore, relevant analysis of the challenges facing SWDs in STEM must be explored, which often begins in high school (Gokool-Baurhoo & Asghar, 2019). The appropriateness of various recommended measures is also assessed for their practicality and applicability.

Previous Research on SWDs and STEM

Several disparities in STEM education exist, including gender, race and ethnicity, socioeconomic status, people with disabilities, and those from generally underrepresented backgrounds (Charlesworth & Banaji, 2019; Xie et al., 2015). Limited research has been conducted to help consider the driving force of these visible disparities regarding SWDs within the STEM realm (Charlesworth & Banaji, 2019). Hence, this calls for further assessment on the extent to which SWDs are likely to participate in programs such as STEM enrichment and support. Another suggestion to help provide relevant and critical information to the disparities is assessing the degree to which SWDs take STEM courses in high school. The desired outcome described by the participatory framework is determining the effect of STEM enrichment courses on graduation rates for SWDs in high school.

To help answer the research questions, several analytical themes can be examined from previous literature, which will act as a guide toward obtaining the relevant responses to the queries posed.

SWDs and STEM Support

Powel et al. (2018) underscored the importance of inclusive STEM classrooms as one of the key support systems which would enhance the quality of STEM teaching. In an inclusive learning environment, children of different backgrounds and abilities collaborate and learn STEM-related concepts/phenomena. The approach led to the desired outcome of creating active learning that deviates from traditional learning. The result of an inclusive environment requires using and adopting systematic changes that include using both human and material/educational resources. Active learning has been proposed through collaborative and computational opportunities available to the STEM learners and is critical to enhancing the systems-thinking and problem-solving approaches educators use (Sivaraj et al., 2020). The use of technology, for instance, to aid in learning SWDs is an adaptive process that can help create a universal learning design. Chen et al. (2018) reiterated this view by documenting the importance of student-student engagement, which is instrumental in creating and sustaining problem-solving sessions. Using strategies such as Universal Design Learning plays an instrumental role in providing all students with an equal opportunity to learn. The approach is geared toward the improvement of inclusive teaching methods. Chen et al. (2018) confirm the need to implement real-world problems in creating active learning activities. The learning outcomes should be engendered toward a better understanding of the course content and application to real-world situations.

Sithole et al. (2016) underscored some of the challenges faced by learners with disabilities. Some of the problems that contributed to poor performance were inculcated culturally. Some key challenges that could hinder STEM education and growth included high attrition rates, low motivation, and reduced entrant numbers. These challenges highlight the need for greater support for K-12 Education by coupling the practice with content, improving the instructional flexibility, and using interventions to support the participation of SWDs in STEM courses. Integrating the courses is critical to improve student performance and changing the perceptions and attitudes of teachers, administrators, and students. For example, when incorporated into traditional classes, computer-based technologies can supplement face-to-face instruction (Sithole et al., 2016).

Education and learning approaches are dynamic, as demonstrated by the challenges that SWDs face in their academic studies (Plasman et al., 2018). Improving learning outcomes for SWDs comes in the context of instructional practice may not consider the effectiveness of learning methods to accommodate these learners. Some support systems that can be implemented in an educational environment include teaching approaches that use multiple senses, participation in both hands-on and lab experiences, and the use of demonstrations given by the instructor. These accommodations are critical for Universal Design Learning (Plasman et al., 2018). Nieminen and Pesonen (2019) continued the discussion on UDL by designing an accessible learning environment. Their study appreciates using the self-assessment process through the actual design, which is not just retrogressive. Solanki et al. (2019) discuss the need for active pedagogical strategies that foster the interaction between the students and the instructors. Active learning can be institutionalized using support networks to bring a sense of belongingness, promote a culture of connectedness, and foster engagement among SWDs to achieve desired outcomes for these students.

Sublett and Plasman (2017) noted the prospect of creating this persistence, where they underscore the importance of developing applied STEM coursework. The teaching of STEM through predominant theoretical approaches can be discouraging to students who face struggles in grasping the content. The lack of connection between the content of the coursework and the real-life application can influence the ability of the students to see the applicability of the learned concepts in real life. The ability of SWDs to apply the knowledge they gain from learning can allow the learners to contextualize key concepts attained in STEM courses. Applying the knowledge can happen through augmentation, relevance, and formulation of new skills. Using these skills has the overall benefit of providing the SWDs with greater self-efficacy in their abilities (Sublett & Plasman, 2017), which can result in greater learning and participation outcomes.

Course Taking

Based on findings from the National Assessment of Student Progress (NAEP), SWDs tend to perform significantly worse in science and math when compared to non-SWDs, even before entering high school (Gottfried & Sublett, 2017). Consequently, SWDs often begin high school with a lower level in science and mathematics courses than students without disabilities (Educational Testing Service, 2021). In the future, these students will accrue fewer units in advanced mathematics and science coursework. These events result in SWDs graduating high school less college-ready in the relevant STEM courses than students without disabilities. In general, students with disabilities are less likely when compared to their counterparts (students without disabilities) to take and succeed in STEM-related coursework in their high school education (Gottfried & Sublett, 2017). These observations are concerning, given that research has shown STEM gaps emanate and present themselves well before the duration of high school (Educational Testing Service, 2021). Therefore, any observable disparities in the courses taken and completion of STEM classes may widen the preexisting STEM achievement gaps.

Regarding the general student population, there is an established connection between completing high school STEM coursework and the associated positive STEM outcomes throughout the education pipeline (Plasman & Gottfried, 2016). SWDs being largely underrepresented in STEM courses generates individual and national implications (Estrada et al., 2016). The recognizable lack of success and employment opportunities for SWDs in the STEM fields limits educational and employment opportunities for this unique group of students (Plasman & Gottfried, 2016). While students within the general population are exposed to high school STEM courses that can enable them to pursue advanced STEM areas of study later, SWDs are not enjoying the same level of exposure. However, research shows that SWDs can achieve success in STEM classes (Plasman & Gottfried, 2016).

SWDs face some serious barriers to education in high school. A significant driver of this achievement gap and the reluctance of SWDs to take STEM courses results from the predominant method of instruction within the classrooms which often does not fit the most effective approaches to learning among SWDs (van Tuijl & van der Molen, 2015). SWDs experience significant challenges with mathematics, reading, and designing concepts, all of which, when combined, hinder a student's abstract-thinking abilities. As a result, SWDs tend to remain at lower levels when compared to the general population in terms of academic performance (Gow et al., 2020; Montez et al., 2017). Several mechanisms have been suggested to help improve school persistence for SWDs. First, there is a recommendation for appropriate accommodation of SWDs to include multiple senses, participation in the hands-on and lab experiences, and the use of more demonstrations by the instructors (van Tuijl & van der Molen, 2015). The recommendation is in line with provisions established by the Higher Education Opportunity Act (van Tuijl & van der Molen, 2015), which states that education should be availed in a manner that prevents barriers to learning, provide relevant accommodations, and maintains a high level of expectations for all students, especially SWDs.

Effect of Support Systems on Different Outcomes

Various institutional practices targeting diversity include programs, policies, and actions to help prepare SWDs for STEM, access to STEM secondary education, persistence within the institution/school, and ultimately employability (Ntombela & Mahlangu, 2019). Possibly the most significant barrier to college access among SWDs is their lack of adequate preparation for coursework in STEM (Ntombela &

Mahlangu, 2019). Indeed, research shows that school counselors and K-12 science teachers often fail to teach and encourage SWDs to pursue STEM-related careers, creating a significant barrier for SWDs to enroll and succeed in STEM undergraduate programs (Lipka et al., 2020).

There is also a lack of representation of SWDs in the STEM fields (Lipka et al., 2020; Weatherton et al., 2017). One factor that contributes to SWD disparities in education is a lack of institutional support. Some high schools have even gone as far as to state that accommodating some SWDs (e.g., those who are visually impaired) is a burden to the operations of the various STEM departments (Koshy-Chenthittayil & Farfan, 2019). A common issue that constantly emerges is the dynamics of the supply-and-demand of assistive software that can support the learning of SWDs like deafness and blindness. SWDs also complain about the ignorance portrayed by members of the various high school faculties and staff members, making it challenging to obtain the necessary help they may request or need (Koshy-Chenthittayil & Farfan, 2019).

Several proactive institutional practices have been suggested to help increase the access that SWDs must STEM courses (Means et al., 2017; Merolla & Serpe, 2013). Students must enter and exit all the available school facilities, especially settings like restrooms and emergency exits, efficiently and safely (Burgstahler, 2009). Accessibility guidelines for buildings and facilities provide all the relevant instructions for parking, egress, movement through school buildings, and general compliance to support SWD in productive ways to ensure their success instead of just compliance (Burgstahler, 2009). The use of assistive technologies is further implemented to help SWDs overcome many physical barriers present within laboratories, classrooms, and in the field (AAAS, 2014).

The appropriate communication of evidence-based practices is also critical among key stakeholders tasked with promoting the inclusion of SWDs in STEM courses and careers (AAAS, 2014; Lipka et al., 2020). There is no need to devise approaches or policies to address barriers for SWDs if they cannot be effectively communicated to help achieve the desired outcomes (Koshy-Chenthittayil & Farfan, 2019). Hence, communication directed to educators, administrators, and policymakers should focus exclusively on alleviating the conditions that have resulted in the underrepresentation of SWDs in STEM, including the inclusion of applicable technologies to help SWDs, inclusive teaching, research, and adequate appropriation of resources (Koshy-Chenthittayil & Farfan, 2019). Such interventions are expected to significantly improve participation in STEM courses by high school-level SWDs. Increased participation of SWDs within STEM fields at high school provides a huge pool of potential SWDs who can continue their academic pursuits at higher education and postsecondary institutions. The potential can help increase the rates of SWDs joining higher education institutions and pursuing STEM-related courses, which will eventually place SWDs strategically within the STEM career market. All the above measures and mechanisms aim to improve the lives of SWDs pursuing STEM-related courses. As pointed out, barriers to STEM education are most prevalent at the high school level, and hence the gaps in high school must be closed to facilitate the accomplishment of the desired goals.

Connection to the Study

The connection to the study underscores these learning approaches that can help SWDs not only enrol in STEM courses but also complete them. The current research would address the knowledge gaps on the key initiatives' overall outcomes. Understanding the outcomes is critical to advocate for learning practices that will encourage higher participation and overcome the barriers which hinder the success of SWDs in the STEM curriculum.

Enrichment programs are supported by foundational learning theories (e.g., social learning and social cognitive theories). In his social learning theory (1977), Bandura emphasized observational learning and modeling, such as enactive learning, which is a concept in support of enrichment programs (Gottfried & Plasman, 2018). In enactive learning, Bandura distinguishes between learning and knowledge-based performance (Podgurski, 2016). The connection to the research is to examine if these programs benefit SWDs as students and how much enrichment can promote strong higher education and career outcomes. Notably, the study outcomes focus on understanding some of the student factors that affect the overall performance of the SWDs in STEM. It is, therefore, critical to incorporate cognitive, skill-based initiatives and practical approaches appealing to the SWDs to enhance their participation in STEM curricula. The suggestion is supported by Bandura's social cognitive theory, which underscores ways people develop social, emotional, cognitive, and behavioral skills through self-motivation (Plasman & Gottfried, 2016). In addition, Vygotsky's sociocultural theory underscores that learning occurs within cultural settings. According to the theory, learning is a co-constructed process that demonstrates the use of shared activities and direct learning (Vygotsky, 1978). The data collected from a longitudinal survey would therefore be considerate of the cultural or demographic context of the data collected.

The study further elucidates the importance of an inclusive learning environment, which is essential to enhancing and broadening the participation of SWDs in STEM courses. The study outlines the importance of investing in high-quality STEM learning that benefits all students, including SWDs. Importantly, it is critical to create sustainability in the participation of SWDs in STEM courses. Encouraging the retention of SWDs in STEM courses plays a crucial role in advancing opportunities for these students. Some of the most appealing approaches come from previous research showing that promoting problem-solving skills and enhancing hands-on learning experiences is critical for SWDs to attain success in STEM courses. Through enrichment programs, the learner is expected to actively engage the curriculum and apply their knowledge beyond the classroom to work in teams, employ effective communication, and implement critical thinking skills. Although such programs can be effective, a lack of conceptualization of STEM teaching and instruction makes it difficult for SWDs in STEM.

CHAPTER 3 RESEARCH METHODS

The following chapter provides an overview of the research methods used in the study. It contains information about the participants, such as the criteria for inclusion and method of selection. The chapter also describes the research design. The instrument used for data collection is also described, as are the procedures followed in this study. The methods used to analyze the data are also discussed. Finally, the research objectives that were addressed during the process are discussed.

The study focused on STEM enrichment programs and their impact on math scores and participation in STEM courses for SWDs (in terms of participation in math classes and STEM courses). These factors can cumulatively affect the engagement levels of students and shape their attitudes toward STEM subjects. The increasing diversity of learners needs to be addressed by ensuring SWDs are at par with their peers in STEM subjects.

Methods and Procedures

The current study was non-experimental. A secondary analysis was also conducted from the High School Longitudinal Study of 2009 (HSLS, 2009). The study analyzed STEM trends among high school SWDs. The HSLS (2009) includes longitudinal data of more than 20,000 students, focusing specifically on SWDs within STEM and their overall scores in math and science courses

Archival data made it possible to measure the dependent variables of interest: math scores and participation in math. Since a primary analysis requires significant resources to collect the data over a long enough period to answer the proposed research questions, utilizing archived data can facilitate a longitudinal analysis and identify data trends. With limited resources, archival data provides a platform where the collected data is present.

Table 1

Variables

Variable	Definition of Variable	Indicator	Type of Variable	Measurement
Math Scores	Dependent	Raw score	Ratio	Numerical
	Independent		**Nominal**	**Binary**
Taking Math Classes	Dependent	Number of math classes taken	Discrete	Numerical
Attend College	Dependent	Number of students	Discrete	Binary

Key:

A1MTHSCIFAIR	A1 A25A Holds math or science fairs/workshops/competitions
A1MSSUMMER	A1 A25B Partners w/ college/university that offers math/science summer program
A1MSAFTERSCH	A1 A25C Sponsors a math or science after-school program
A1MSMENTOR	A1 A25D Pairs students with mentors in math or science
A1MSSPEAKER	A1 A25E Brings in guest speakers to talk about math or science
A1MSFLDTRIP	A1 A25F Takes students on math- or science-relevant field trips
A1MSPRGMS	A1 A25G Tells students about math/science contests/websites/blogs/other programs
A1MESA	A1 A25H Partners with MESA or a similar enrichment-model program
A1MSPDLEARN	A1 A25I Requires teacher prof development in how students learn math/science.
A1MSPDINTRST	A1 A25J Requires teacher prof development in increasing interest in math/science.
A1MSOTHER	A1 A25K Raises student's math/science interest/achievement in another way
A1MSNONE	A1 A25L Doesn't do any of these to raise math/science interest/achievement
A1G9SUMMER	A1 A26A Offers Pre-HS summer reading/math instruction for struggling 9th graders.
A1G9OVERAGE	A1 A26B Offers learning communities for over-age students lacking H.S. prerequisite.
A1G9COMMUNTY	A1 A26C Offers 9th grade learning communities separate from the rest of the school.
A1G9BLOCKSCH	A1 A26D Offers block scheduling to assist struggling 9th graders
A1G9DOUBLE	A1 A26E Offers catch-up courses/double-dosing to assist struggling 9th graders.
A1G9STUDY	A1 A26F Offers study skill seminar/class for struggling 9th graders
A1G9TEACHER	A1 A26G Offers assistance for teachers working with

	struggling 9th graders
A1G9TUTOR	A1 A26H Offers tutoring to assist struggling 9th graders
A1G9OTHRPROG	A1 A26I Offers another program to assist struggling 9th graders
A1G9NOPROG	A1 A26J School has no programs to assist struggling 9th graders.

Research Questions

The following research questions guided the study:

1. Do SWDs who attend high schools with more STEM enrichment programs have higher math scores than SWDs from schools with fewer STEM enrichment programs?
2. Do SWDS who attended high schools with more STEM enrichment programs take more STEM course in high school?
3. Are SWDs who attend schools with more STEM enrichment programs more likely to attend college?

Research Design and Data Analysis

The research design deployed is a non-experimental approach focused on archival or existing data research design. The study used regression analysis for RQ1 and logistic regression for RQ2 to identify the relationships between the independent variable (STEM enrichment) and the dependent variables. The independent variable in this study is the STEM enrichment programs and support that is offered to SWDs.

In total, three research questions were examined. The first question:

1. Do SWDs who attend high schools with more STEM enrichment programs have higher math scores than SWDs from schools with fewer STEM enrichment programs?

The first research question is quantitative and asks how much STEM enrichment programs increase math scores among SWDs. The question compares math scores (dependent variable) of SWDs within schools that have or do not have STEM enrichment programs (independent variable).

The second question:

2. Do SWDS who attended high schools with more STEM enrichment programs take more STEM course in high school?

The second research question is also quantitative and evaluates the extent to which those with more STEM enrichment programs have SWDs are like to take more STEM course. For this question, STEM enrichment programs are the independent variable, and the dependent variable is the number of dual enrollment courses completed in high school.

And the third question:

3. Are SWDs who attend schools with more STEM enrichment programs more likely to attend college?

The third research evaluates how more STEM enrichment programs increase SWDS college attendance. The research question allows for comparing school attendance (dependent variable) of SWDS with more STEM enrichment programs and college attendance (independent variable).

The current study utilized a regression analysis approach to strengthening the overall conclusions drawn by implementing a quantitative data analysis on/via existing archival data from HSLS (2009). For this study, a non-experimental design was the optimal design because it contributes to identifying both the extent to which STEM enrichment programs and support influences the coursework of SWDs during their STEM studies and the best practices for developing these programs and support based on reported data.

Archival data from the HSLS (2009) survey was used in answering the research questions. The choice of the data comes from its richness. Most of the sample members were 11th graders in the random selection of the participants. The data have important metrics such as grade progression and the transitions following high school completion. The data also played a role in understanding effective high schools and the growth in mathematic achievements.

Reliability and Validity of the Research Design

The survey adopted and implemented a Web-based system to collect the relevant data with built-in edits and other quality checks that helped process the data when entered into the system. Although this process addresses the issue of data consistency, it fails to directly address the accuracy of the data provided by institutions or the reliability of the data in general. It was highly likely that some institutions could have provided data items that were internally consistent when submitted but were inaccurate regarding the institution's characteristics they are intended to represent.

However, adjustments were made for the prior-year data submissions. Using the Prior Data Revision System, institutions could correct errors to previously submitted data or data they had failed to submit. The HSLS (2009) mathematics assessment focused on algebra skills, reasoning, and problem-solving. All the documents acquired during the research's search phase were analyzed for evidence of an evaluation study that may provide credible information on a program's effectiveness or specific qualities. While many programs include descriptive "evaluation" materials such as numbers of students served, the numbers of students who go on to college, and the like, or formative studies that attempt to provide feedback to program implementers about how the program works, few conduct rigorous outcome evaluations with comparable comparison or control samples.

The Sample and Population

Sample

The population chosen for this study are students with disabilities (SWDs) from the K-12 education system in the U.S. The study focused on 9th grade students with one or more forms of physical disabilities that act as a barrier to learning (i.e., SWDs). The population comprises students diagnosed with one or more forms of disabilities, as listed in the Individuals with Disabilities Education Act (IDEA). Disabilities listed in the IDEA include autism, emotional disturbance, hearing impairment, and learning disabilities (U.S. Department of Education, 2020). In recognition of these disabilities, IDEA requires special education and other critical support systems for eligible students (Lee, 2019).

The National Center for Education Statistics described the sampling technique used in the survey as a random sampling method. The sampling method is informed by the need to understand the phenomenon of interest in which there is a comparison between the use of enrichment programs and the failure to adapt these support systems (Etikan et al., 2016). The approach is therefore, appropriate because it will help support the inclusion of SWDs. The sample itself is relatively homogenous because there is a need to observe participants who share similar traits or characteristics (Etikan et al., 2016).

Students were randomly chosen from a sample of high schools to participate in HSLS (2009). The parents, teachers, school administrators, and the lead counsellors from each school were invited to participate in the survey. A nationally representative sample of 944 public and private high schools participated in the base-year study. An average of 25 ninth graders from each school were chosen to participate, for over 24,000 students. Over 21,000 students from this sample responded to the survey.

Population

The population for the study is high school students with disabilities, with a specific focus on students in the 9th grade and following them throughout high school. The focus on this population would help understand the impact of STEM enrichment programs when shaping the attitudes in science and math subjects. Besides, it would be important to underscore the successful graduation rates and improved scores in both subjects.

Instruments

For the archival data, the government survey was used as the research instrument to help answer the questions posed. Data used to answer the questions was derived from the High School Longitudinal Study of 2009 (HSLS, 2009). The database provided reliable data on the trends in mathematics and science advancement among U.S. students compared to students from other countries.

Procedures for Collecting Data

The approach that was deployed to help assess and collect the targeted data relied on the collection of archived data. To answer the research questions, the study relied on the High School Longitudinal Study of 2009 (HSLS, 2009). The data from this database source follows a national cohort of 11th graders from public and private U.S schools. The approach was critical in understanding the educational and developmental environment among students with disabilities. Consistency checks were completed to resolve any discrepancies obtained in survey data if any differences occur. Some checks included evaluating the context of enrichment programs initiated and the course credits earned following the implementation of support programs.

Research Ethics

The Institutional Review Board (#IRB-FY2022-297) of St. John's University approved the current study. The review board was debriefed on the critical research process, purpose, and possible outcomes from the data collected from the targeted database following the conduct of the procedures. The review board was assured that the information collected was strictly used for academic purposes and not commercialized.

CHAPTER 4 RESULTS

The following section covers the study's findings; SPSS was used to analyze the data collected.

Descriptive Statistics

Table 2 shows the descriptive statistics of the enrichment variables. A total (N) of 9,624 were regarded as valid and used in this study for analysis. The math score was used to measure the impact of stem enrichment programs on students of disability and non-disability. From Table 2, the MATH scores ranged from 25.01 to 99.99, with a mean of 69.20 and a standard deviation of 17.60, suggesting a wide range of math scores. As a result, this might be because of disability or differences in enrichment programs. However, the stem credits ranged from 0 to 16, with a mean of 7.93 and a standard deviation of 2.26. The mean of 7.93 indicates that most students took less than half of the STEM credits.

Table 2

Descriptive Statistics of the Enrichment Parameters

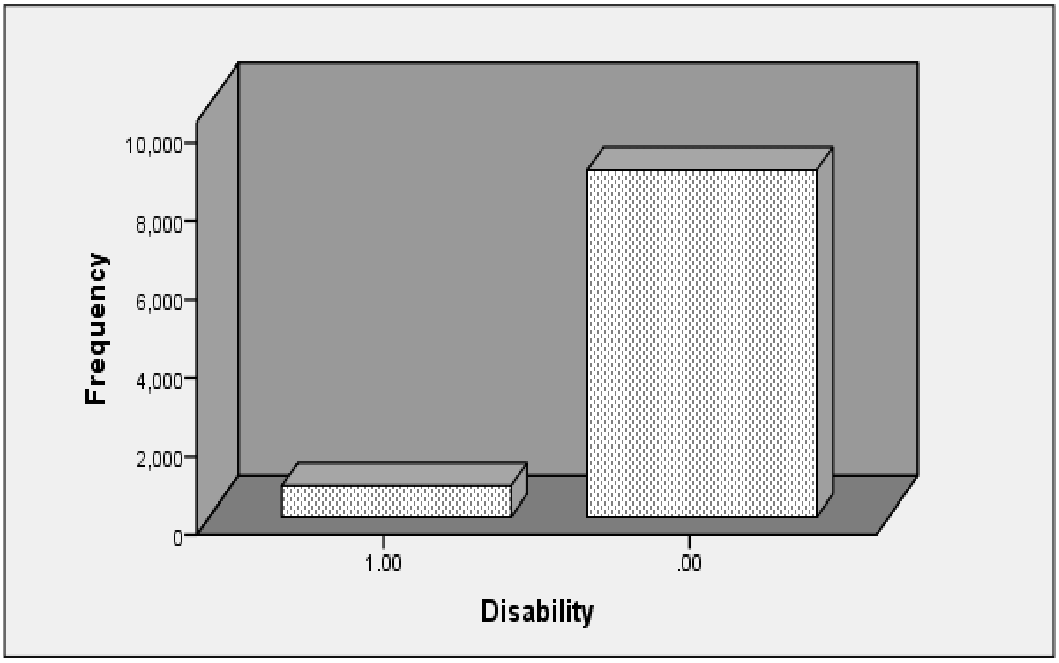
Parameters	N	Minimum	Maximum	Mean	Std. Deviation
Disability	9624	.00	1.00	0.08	.27
STEMRICH	9624	.00	9.00	4.67	2.21
Math Scores	9624	25.01	99.99	69.18	17.57
STEM Credit	9624	.00	16.00	7.92	2.26
College Attendants	9624	.00	1.00	0.75	.42
Valid N (listwise)	9624				

Disability Groupings

The number of high school and college students were interviewed to determine the number of disabled and non-disabled. Figure 1 shows the proportion of disabled (1.00) and non-disabled students (.00). Overall, 8.2% (n = 787) of the students responded as having a disability that affected their ability to succeed. The disability conditions indicated by the respondents were learning disability, attention-deficit/hyperactivity disorder, psychological condition, medical/systemic impairment, deaf/hard of hearing, mobility impairment, blindness/low vision, speech disorder, brain injury, and an autism spectrum disorder. However, 91.8% of the students (n = 8,837) indicated that they had no disabilities (to serve as a no-disability comparison group resulting in two groups: (group 1 = disability) while (group 0 = non-disability) resulted in a total sample size of 9,624 (see Figure 1).

Figure 1

Proportion of disabled (1.00) and non-disabled students (.00)



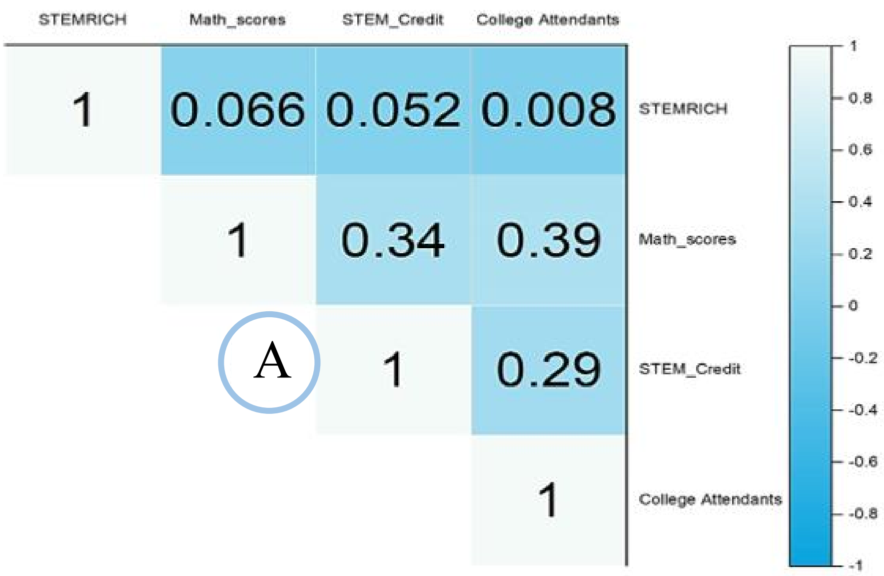
Correlational Analysis

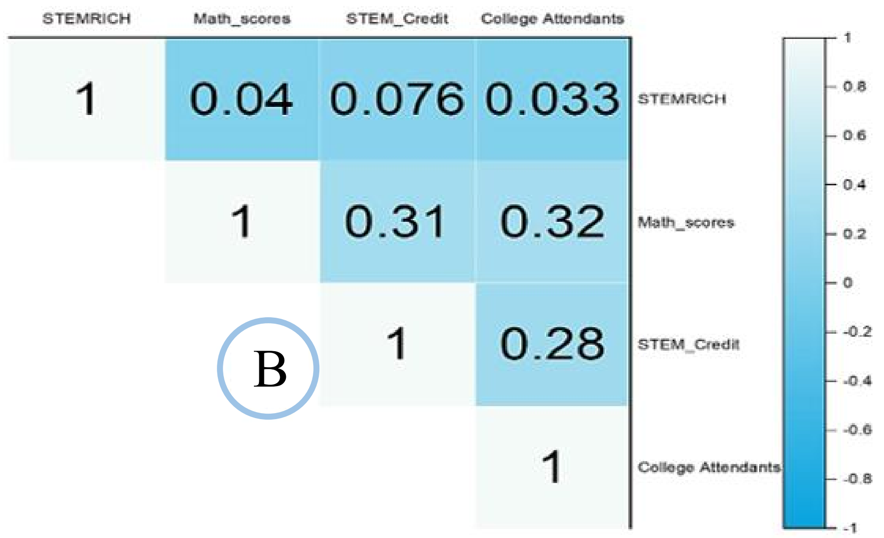
First, I conducted a Pearson correlation matrix to determine the relationship among the enrichment variables. The Pearson correlation matrixes of the four (4) variables associated with students with disabilities and non-disabilities are shown in Figure 2 (see A and B). Findings reveal that there were positive relationships between the implementation of STEM enrichment programs at high schools, math scores of

SWDs, Taking STEM courses in a high school, SWDS attending high school, and Attending College by SWDS factors.

Figure 2

Correlation plot of the dependent and independent variables for (a) disabled, and (b) non-disabled students





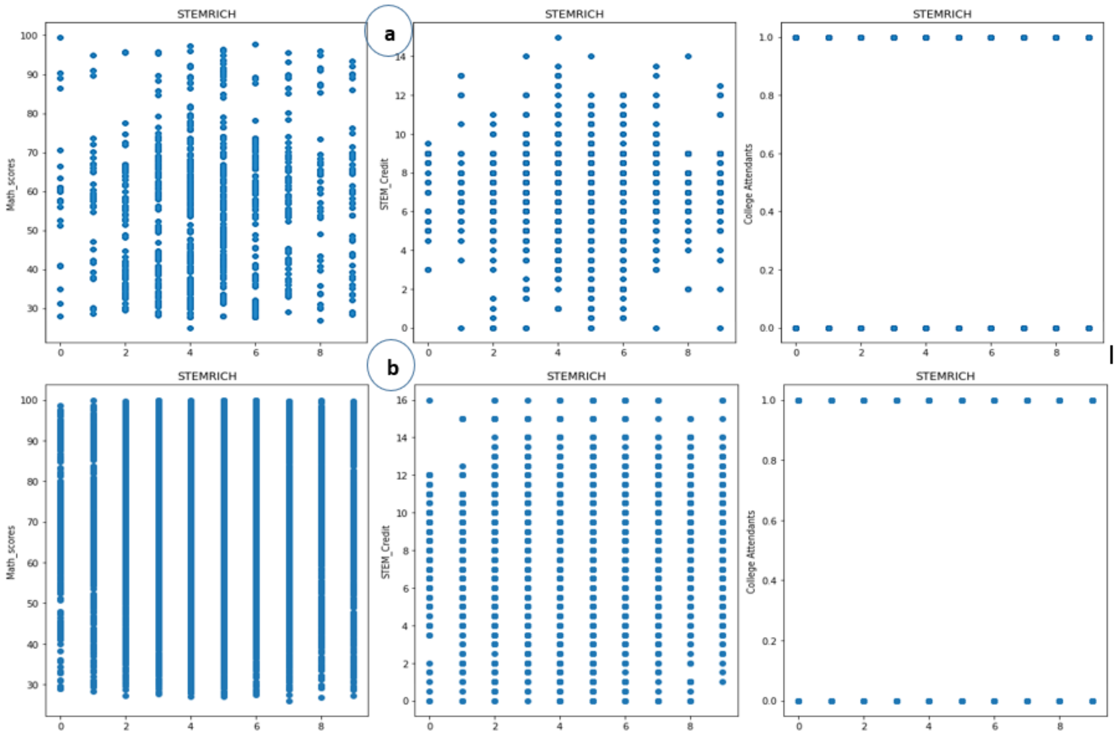
Results

Bi-plots between STEM enrichment versus math scores, the total number of stem credits, and college attendants of students with disabilities and non-disabled were explored. The results are shown in Figure 3 (see A and B). The goal was to see if the increased STEM enrichment programs significantly affect student math scores or the total number of credits offered in college.

The data points representing each variable are at acute angles for the relationship between STEM enrichment programs and math scores. The findings imply that the relationship between STEM enrichment and math scores among SWDs is correlated. The data points representing each variable are almost at right angles for the association between STEM enrichment programs and STEM credit scores. The findings imply that the relationship between STEM enrichment and STEM credit scores among SWDs is weakly correlated. For the relationship between STEM enrichment programs and college attendance, the angles between the vectors representing each variable are at right angles. Therefore, we conclude that STEM enrichment and college attendance among SWDs are uncorrelated.

Figure 3

Scatter plot of the stem enrichment variable versus response variables for (a) disabled, and (b) non-disabled students



Linear Regressions Analysis

Several linear regression models were produced to determine the relationship between STEM enrichment and math scores, STEM credit, and College Attendants of disabled students. In the various models, the STEM enrichment is considered the independent variable, while the math scores, STEM credit, and College Attendance are the dependent variables. Table 3 shows the linear regression model of STEM enrichment and math scores. From the model, it could be observed that R-Squared is only 0.004. R-Squared, also called the coefficient of determination, is the amount of variance expressed as a percentage explained in the dependent variables by the independent variable. For an excellent evaluation of a linear model, the R-Square must be greater than 30%. Here, the R-Squared is significantly small (0.004) and thus indicates that only 0.4% of the variability of the dependent variables is explained by the independent variables. The ANOVA (Table 3) shows that the p-value (0.064) is greater than 0.05 and thus indicates the insignificant relationship between the STEM enrichment and math scores. However, the coefficient section of Table 3 demonstrated two types of coefficients i.e., the unstandardized and standardized coefficients. It could be seen that the unstandardized coefficient (slope) was 0.53, thus predicting that the independent variable (STEMRICH) has a slight effect on the dependent variable. Doing so implies that by increasing the STEM enrichment programs by one unit, only a 0.53 increase in math score will be achieved. Although it was not significant at the $p < .05$ level, it is marginally significant at the $p < .10$ level. This implies that stem enrichment programs lead to some marginal increase in math scores. Thus, establishing stem enrichment programs in schools and mainly focusing on SWDs would be necessary to enhance a rise in math scores.

Table 3

Linear Regression of STEM Enrichment vs. Math Scores

				Model Summary					
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error**	**R Square Change**	**F Change**	**df1**	**df2**	**Sig. F Change**
1	.066[a]	.004	.003	17.22298	.004	3.448	1	785	.064

				ANOVA	
	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Regression	1022.918	1	1022.918	3.448	.064[b]
Residual	232855.382	785	296.631		

				Coefficients[a]				
	Unstandardized Coefficients		**Standardized Coefficients**					
	B	**Std. Error**	**Beta**	**T**	**Sig.**	**Zero-order**	**Partial**	**Part**
(Constant)	53.016	1.454		36.466	.000			
STEMRICH	.530	.285	.066	1.857	.064	.066	.066	.066

Table 4 shows the linear regression model of STEM enrichment and STEM credit. From the model, it could be observed that R-Squared is 0.003 (0.3%). The unstandardized coefficient (slope) was 0.06, thus predicting the independent variable

(STEMRICH). The prediction implies that if increasing the STEM enrichment programs by one unit, there will be approximately a 0.06 increase in stem credits taken by disabled students. However, the relationship between STEM enrichment and STEM credits was not statistically significant. Thus, STEM enrichment is not a reliable predictor of STEM credits.

Table 4

Linear Regression of STEM Enrichment vs. STEM Credit

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error	R Square Change	F Change	df1	df2	Sig. F Change
1	.052[a]	.003	.001	2.51781	.003	2.099	1	785	.148

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	13.306	1	13.306	2.099	.148[b]
Residual	4976.410	785	6.339		

Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients					
	B	Std. Error	Beta	T	Sig.	Zero-order	Partial	Part
(Constant)	6.695	.213		31.500	.000			
STEMRICH	.060	.042	.052	1.449	.148	.052	.052	.052

Logistic Regression

A binary logistics regression was employed in dichotomous data to determine the relationship between STEM enrichment and college attendance. A binary logistic regression is an extension of conventional linear regression. It is applied when the dependent variable, Y, is categorical. The current study's outcome or dependent variable is college attendance (yes or no), while the independent variable is the number of STEM enrichment programs.

Table 5 shows the coding of the independent variable (STEMRICH). Two blocks are involved, and these include Block 0 and Block 1. Block zero assumes that there is no independent variable; thus, every individual is assigned the same probability of relevance. It is regarded as the baseline of the model. Block 1 has the most meaningful interpretation of any logistic regression. It contains all the selected independent variables and thus demonstrates distinct significance amongst the variables.

Table 5

Omnibus Tests of Model Coefficients

		Chi-square	Df	Sig.
Step 1	Step	.050	1	.823
	Block	.050	1	.823
	Model	.050	1	.823

Table 6 shows the model summary. Two critical components are involved: The Cox & Snell and the Nagelkerke R squared. However, the latter is the most useful for interpreting a logistic model. From Table 6, the Nagelkerke R-value is 0.000 and thus indicates that the STEM enrichment programs could explain 0% of the college attendance. Doing so suggests a lack of a positive correlation between STEM enrichment programs and college attendance among SWDs.

Compared to a logistic model for all students, the Nagelkerke R-value is 0.001 and thus indicates that the STEM enrichment programs could account for 0.01% of college attendance (see Table 7). This implies that the STEM enrichment programs have a higher explanatory power in predicting college attendance among all students than the program implementation among SWDs.

Table 6

Logistic Regression Model Summary for SWDs

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1090.169[a]	.000	.000

a. Estimation terminated at iteration number 2 because parameter estimates changed by less than .001.

Table 7

Logistic Regression Model Summary for all Students

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	10609.926a	.001	.001

a. Estimation terminated at iteration number 3 because parameter estimates changed by less than .001.

Table 8 explains the variables in the equations. The first thing to take into consideration is the sig. column, which contains the p-values. The p-value was 0.823, which is more than 0.05. At a significant level of 0.05, undertaking STEM enrichment programs in school was not statistically associated with college attendance among SWDs ($p > 0.05$). The Exp(B) value was 1.007. This implies that the STEM enrichment programs in school increase the level of college attendance among SWDs by 1.007 times. The findings suggest that the STEM enrichment programs in school improve college attendance among SWDs positively but insignificantly. Therefore, we conclude that the number of STEM enrichment activities does not increase the odds of attending college by SWDS.

Compared to a logistic model for all students, the p-value was 0.002, less than 0.05. The Exp(B) value was 1.034. Thus, the STEM enrichment programs in school increase college attendance among the student population by 1.034 times or about 3.5%. This implies that among all the students, the STEM enrichment programs in school improve the level of college attendance significantly and positively. We conclude that STEM enrichment programs significantly increased the odds of attending college for all students preparing for college (general student population). This further implies a factor in place during STEM enrichment programs for all students that are missing or not well expressed for the students with disabilities.

Table 8

Variables in the Equation for Students with Disabilities

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a	STEMRICH	.007	.033	.050	1	.823	1.007
	Constant	.029	.169	.030	1	.863	1.030
a. Variable(s) entered on step 1: STEMRICH.							

Table 9

Variables in the Equation for all students

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a	STEMRICH	.033	.011	9.304	1	.002	1.034
	Constant	.997	.055	328.110	1	.000	2.710
a. Variable(s) entered on step 1: STEMRICH.							

Summary of the Findings

The study examined whether STEM enrichment programs in high schools improve SWDs' math performance compared to schools that do not have similar programs. The data revealed that the R-Squared is relatively small (.004), indicating that the number of STEM enrichment supports explains only 0.4% of the variance in math score accomplishment. Including STEM enrichment programs in high schools seems to have resulted in a slight increase in math achievement.

The study examined whether taking STEM enrichment in high school was associated with SWDS taking additional STEM credits. The results show that the R-Squared is 0.003. As a result, there was very weak link between STEM enrichment and taking more STEM courses. As a result, STEM enrichment is not a good predictor of STEM course completion.

The study assessed whether the number of STEM enrichment activities increases the odds of attending college by SWDS. Findings in this study regarding research question 3 show that the R-Squared value is 0.0%, thus suggesting that STEM enrichment has no effect on college attendance among SWDs. We, therefore, conclude that no effect was observed for college attendance among SWDs as a result of STEM enrichment programs.

CHAPTER 5 DISCUSSION

The main goal of this study was to evaluate the role of STEM enrichment on course-taking and academic performance for high school students with disabilities. This is the final chapter of the analysis, which elaborates on the results in chapter four and gives a summative conclusion of the study's findings. The current chapter is divided into an introduction (which provides a brief outline), a general discussion of findings, the research questions, theoretical and practical implications of the study, recommendations for future practice and study, and research limitations.

Interpretation of Findings

My first hypothesis was that the implementation of STEM enrichment programs at high schools increases the math scores of SWDs compared to schools that do not implement these programs. My analysis suggested minimal evidence for this.

The findings revealed that the R-Squared is quite small (.004) and thus indicates that only 0.4% of the variance in math score achievement is explained by the number of STEM enrichment supports. Implementing STEM enrichment programs at high schools suggests a slight increase in math achievement, but only at the $p < .10$ level. It is possible that if the sample size for SWDs was more significant, the result of a half-point increase for each enrichment variable would be more significant.

Similar results were reported by Kioupi and Voulvoulis (2019), who found that learning outcomes were improved by deploying support systems to enhance learning and knowledge retention among SWDs. The assessment and monitoring also aid in developing knowledge of the efficacy of methods and tactics employed to satisfy the learning requirements of SWDs in STEM. Although SWDs can succeed in STEM classes, Plasman and Gottfried (2016) stated that the lack of exposure prevents SWDs from pursuing advanced STEM fields of study in the future. SWDs are significantly underrepresented in STEM fields, affecting individuals and the country (Estrada et al., 2016). SWDs frequently start high school with a lower level in science and mathematics courses than children without impairments, according to Gottfried and Sublett (2017). As a result, SWD students continue to earn fewer units in advanced science and mathematics courses.

According to the report's findings, STEM enrichment programs may benefit math test scores for children with impairments, although the effect may be insignificant. It's likely that other elements, such as the quality of education, teacher preparation, and student engagement, may have a greater impact on the academic performance of these pupils.

For certain children, the marginal impact of STEM enrichment programs may still be substantial. Even a slight improvement in math test results might be a significant accomplishment for children with difficulty with arithmetic or who lack confidence in their skills (Gottfried & Sublett, 2017). STEM enrichment programs may also enhance student enthusiasm and participation in STEM subjects, foster cooperation and collaboration, and build students' critical thinking and problem-solving abilities and academic success.

My second hypothesis was that taking STEM enrichment in a high school would be associated with SWDS taking more STEM credits. In the testing of the hypothesis, the R-Squared is 0.003. The study revealed no relationship between STEM enrichment and taking more STEM courses. Therefore, STEM enrichment is not a reliable predictor of STEM course completion. This analysis has fundamental limitations since the number of STEM credits may be more linked to state or school requirements for graduation than taking elective STEM courses voluntarily. Still, this analysis has implications for thinking about the system taking for STEM students.

To increase SWD engagement in the STEM curriculum, Plasman and Gottfried (2016) emphasized that it is crucial to include cognitive, skill-based activities and practical techniques that engage SWDs. According to Koshy-Chenthittayil and Farfan (2019), representation of SWDs in STEM, appropriate technologies to assist SWDs, inclusive education and instruction, integrated studies, and sufficient resource allocation all significantly increase SWDs' involvement in STEM courses at the high school level. An enormous pool of potential SWDs who can pursue their academic endeavors at postsecondary learning and tertiary institutions is made available by the increased engagement of SWDs in STEM disciplines in high school. If hurdles for SWDs cannot be successfully articulated, Lipka et al. (2020) suggest developing techniques or policies to overcome those barriers to assist in achieving the intended goals.

STEM education may help students become more creative, innovative, and critical thinkers. These abilities are particularly crucial for SWDs, who may have significant difficulties in obtaining educational and career opportunities. SWDs can develop vital skills to help them thrive in the workplace and society by accessing STEM education.

STEM education may provide advantages, but SWDs must overcome special obstacles to enroll in these programs. These obstacles may include a lack of money, accommodations, or societal stigma (Plasman & Gottfried, 2016). For SWDs to have equitable access to STEM education and the possibilities it offers, these barriers must be addressed.

It is crucial to support inclusive education policies prioritizing the needs of SWDs to overcome these obstacles. This might entail offering extra resources and accommodations to guarantee that SWDs have equitable access to STEM courses. It may also entail fostering an inclusive school atmosphere and improving societal perceptions about SWDs.

The third hypothesis was that the number of STEM enrichment activities increases the odds of attending college by SWDS. Findings in this study regarding H3 show that the R-Squared value is 0.0%, thus clearly suggesting that STEM enrichment has no effect on College Attendance among SWDs. The Exp(B) was 1.007 (p-value of 0.823) and thus demonstrated the extremely insignificant effect of STEM enrichment on the dependent variable called College Attendance. This implies that the STEM enrichment programs in school increase the level of college attendance among SWDs by 1.007 times. We, therefore, conclude that no effect was observed for college attendance among SWDs as a result of STEM enrichment programs.

The STEM enrichment programs in school increase college attendance among the student population by 1.034 times. Among all the students, the STEM enrichment programs in school improve the level of college attendance significantly and positively. We conclude that STEM enrichment programs significantly increased the odds of attending college for all students preparing for college as part of the general student population. This further implies that there is a factor in place during STEM enrichment programs or students than for the students with disabilities. Johnson (2006) noted that it is crucial to consider the context in which STEM enrichment activities are provided. Although they may offer useful experiences and skills, these programs—which frequently target high school students—might not address the structural challenges students with disabilities have when trying to attend higher education.

According to a Podgurski (2016) study, SWDs benefit from STEM enrichment programs as students and how much enrichment may support successful outcomes in higher education and careers. Sithole et al. (2016) recognized the use of interventions to assist the engagement of SWDs in STEM courses, the improvement of instructional flexibility, and the coupling of practice with material for SWDs.

Contrary findings by Johnson (2006) showed that students with disabilities, especially learning disabilities, often encounter ill attitudes from faculty and peers (Johnson, 2006). Therefore, they are already discouraged from pursuing STEM courses by the time they reach college. Johnson's (2006) study noted with the introduction of STEM enrichment programs, these students will have more courage and confidence to continue with STEM. Contrary to our findings, he concluded that this could tend to improve with the intervention of STEM enrichment programs.

Notwithstanding the positive effect of STEM enrichment programs on student math scores and the number of STEM courses offered in college, too much (greater than 4) of it could tend to be detrimental. Disabled students need time to study individually. If offered so many STEM enrichment programs, they will become bored with it, distorting their preparation for examinations and leading to lower math scores.

However, there is no significant relationship between STEM enrichment programs and the number of student attendants (Podgurski, 2016). This is because most disabled students attend college even if they are not offered STEM courses. Thus, that could increase the number of students irrespective of taking stem enrichment programs.

Conclusion of the Study

STEM enrichment programs, which usually target high school students, may provide valuable experiences and skills, but they might not address the institutional barriers that students with disabilities face when attempting to enroll in higher education. Programs for STEM enrichment for kids with disabilities may need to be customized to fit their unique requirements and difficulties to be as effective as possible. Students with learning disabilities may profit from additional assistance and adaptations to ensure their success in math and other STEM disciplines. At the same time, children with visual impairments may need specific tools and materials to interact with STEM curriculum.

Recognizing the intersections of disability and other oppressed identities is also essential. For instance, SWDs who belong to marginalized ethnic or racial communities could encounter more difficulties enrolling in STEM courses. To advance inclusive STEM education, addressing structural injustices affecting SWDs and other disadvantaged groups is crucial.

The fact that high school STEM course enrollment is only tangentially related to SWDs enrolling in high school emphasizes the need to implement inclusive education reforms that place that SWDs demand. Schools can enable SWDs to develop useful skills and thrive in the workforce and community by ensuring access to STEM education.

For instance, it could be difficult for disabled students to get the accommodations—like accessible housing, transportation, and course materials—required to thrive in college. They could also experience discrimination and intolerance from their professors and peers. It needs a comprehensive strategy beyond merely providing STEM enrichment programs to address these structural impediments.

Concerning theory, Weaver-Hightower’s ecology metaphor can help us understand the multiple factors at play. For example, the availability of STEM resources, the support of teachers and peers, and the student’s interests and abilities may influence their engagement and success in STEM courses. Moreover, the metaphor can help us think about creating more supportive and inclusive learning environments that address the unique needs of students with disabilities. This could involve providing accessible materials and technologies, promoting positive attitudes and behaviors toward disability, and fostering a sense of belonging and community among students with disabilities. Finally, Weaver-Hightower's ecology metaphor can provide a useful framework for understanding the complex interplay between different factors that contribute to student success in STEM and other academic domains, especially for those who may face additional barriers to learning.

Limitations of the Study

The study had a wide and limited sample size, which could limit the specificity of the findings. The study focused on students with disabilities (SWDs) from the K-12 education system in the United States, where further research should be done on different individual states for more accurate conclusions and testing of other geographical areas. The measures of academic performance used in the study could be subjective or may not accurately reflect student knowledge and skills in STEM subjects. Alternative assessment of academic performance among the students could manage the gap.

The study did not investigate the impact of STEM enrichment programs on post-secondary outcomes, such as significant selection and career paths, for high school students with disabilities. The current study did not consider the cross-sectional research method, which would allow researchers to investigate the direct impact of STEM enrichment programs.

The study included students with a variety of disabilities. The study did not focus on specific disabilities and their response to STEM enrichment programs. Further, the study did not investigate the impact of STEM enrichment programs on students from different socioeconomic backgrounds. Students from low-income backgrounds may benefit differently from STEM enrichment programs.

Recommendation for Future Practice

To fulfill the unique needs and obstacles of kids with disabilities, institutions and teachers should develop and execute STEM enrichment programs. To do this, it may be necessary to offer specific equipment and resources, additional assistance, accommodations, and chances for customized training and feedback.

Investing in teacher education and professional training ensures that STEM enrichment initiatives for kids with disabilities are as effective as possible. This can entail offering lessons in differentiated instruction, assistive equipment, and equitable teaching methods. Educational institutions and staff members must work together to promote diversity and inclusion in STEM education. This might entail supporting inclusion and diversity in STEM disciplines, motivating students with disabilities to pursue STEM professions, and allowing all students to participate in STEM-related projects and activities.

Schools and educators should work to establish collaborations and partnerships with local businesses, industry leaders, and other partners to increase the effect of STEM enrichment programs. These collaborations may give students access to essential tools and knowledge and projects and problems from the actual world of science.

To ensure that high school students with disabilities have access to high-quality STEM enrichment programs, increasing funding for such programs is crucial. Doing so could be done by seeking out grants or donations from private organizations or government agencies. STEM enrichment programs should be expanded to reach a broader range of high school students with disabilities. This could be done by offering programs at more schools or by making them available online.

Participation in STEM competitions can be a great way for high school students with disabilities to showcase their skills and gain recognition for their achievements. Schools should encourage students to participate in such competitions and support them. High school students with disabilities interested in STEM would benefit from mentorship opportunities. This could involve pairing students with STEM professionals or college students studying STEM fields.

Many high school students with disabilities may not be aware of the range of career opportunities available in STEM fields. Schools should provide information about STEM careers and work with local businesses to offer job shadowing or internship opportunities.

Recommendation for Future Research

Future research studies could investigate which components of STEM enrichment programs (e.g., mentoring, tutoring, hands-on experiences) are most effective in improving course-taking and academic performance for high school students with disabilities. Researchers could investigate the impact of STEM enrichment programs on post-secondary outcomes, such as college enrollment, primary selection, and career paths, for high school students with disabilities. Conducting a cross-sectional research method would allow researchers to investigate the direct impact of STEM enrichment programs on the academic and career outcomes of high school students with disabilities. In the future, other researchers can use a questionnaire survey tool to collect primary data from respondents.

Future research should explore the impact of STEM enrichment programs on students with different types of disabilities. The study included students with various disabilities, but future research could focus on specific disabilities and their response to STEM enrichment programs. For example, the researchers could examine the impact of these programs on students with physical disabilities or autism.

Further, future research should investigate the impact of STEM enrichment programs on students from different socioeconomic backgrounds. The current study did not examine the relationship between socioeconomic status and program outcomes, but students from low-income backgrounds may benefit differently from STEM enrichment programs.

Conclusion

Students who participate in STEM enrichment programs are more likely to take advanced STEM courses in high school and achieve higher academic performance in STEM subjects than those who do not participate. Therefore, it is essential to ensure that STEM enrichment opportunities are available and accessible to students with disabilities to support their academic success and prepare them for future STEM careers. The results of this study can inform educators and policymakers in developing effective strategies to support the academic achievement of students with disabilities in STEM subjects.

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