https://doi.org/10.55737/trt/FL25.155

THE REGIONAL TRIBUNE

Pages: 141 – 160 | Volume: 4 | Issue: 4 (Fall 2025) | ISSN (Online): 3006-8428 | DOI: 10.55737/trt/FL25.155

Early STEM Exposure and Career Aspirations: A Longitudinal Study of How Primary-Level STEM Activities Shape Students' Future Academic and Professional Pathways

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ABSTRACT: The issues that were addressed by this longitudinal research design are the impacts of exposure to STEM (Science, Technology, Engineering and Mathematics) activities in early age on academic achievement, self-efficacy and the career choice of students in the STEM fields. The study will involve the investigation of the impact of STEM engagement at an early age on the students' academic performance and the aspiration of early school students on the career possibilities associated with STEM among a cohort of over five years. The results demonstrate that students that were exposed to frequent performances of STEM activities accrued a lot of self-efficacy and higher performance in the STEM subjects. Moreover, the study is able to come up with extremely good correlation between increased participation in the STEM activities and a subsequent increment in career goals in the future, more so in staggering STEM. The problem of the gender and racial difference was also touched upon, and female students and minority students turned out as more self-efficient and having more interests in the STEM-related professional world because of the earlier exposure. The study is also applicable to the available literature on the preliminary exposure of STEM and also provide a thought that can prove valuable to methodical educators and policymakers who can form a multidiverse and competent future STEM talent.

KEYWORDS: Early STEM Exposure, Self-efficacy, Academic Achievement, Career Aspirations, Gender Disparities, Racial Disparities, STEM Education, STEM Activities, Educational Policy

Introduction

The introduction to the pursuits of Science, Technology, Engineering, and Mathematics STEM in early life has assumed a necessity role in shaping out the oaths of students in school and career. This has been the case in the last couple of years and was referred to as a rediscovery of the need to incorporate STEM subjects in the lower level of education. Not only does young STEM education formulate cognition and problem solving but will make a significant impact on student opinion regarding their cognition and capability in such tasks. The crucial figure in assuring what students pursue in the future is early life experiences in primary school, which affect their future choice of STEM career paths. The researchers conducted study can prove that the engagement in STEM activities in primary school might have had longer-term implications on the academic

Cite this Article: Khoso, F. J., & Sahito, Z. H. (2025). Early STEM Exposure and Career Aspirations: A Longitudinal Study of How Primary-Level STEM Activities Shape Students' Future Academic and Professional Pathways". *The Regional Tribune, 4*(4), 141-160. https://doi.org/10.55737/trt/FL25.155

levels and career orientation behaviour of the pupils, which would potentially lead to the increase of the interest towards STEM careers.

National Science Foundation (NSF) (2021). proposes that there is an urgent necessity to increase diversity in STEM that is now necessary especially in terms of gender, race, and socioeconomic status. Exposure to STEM in early years has been found to help to challenge these disparities by helping to instigate wonder in students of underrepresented groups, including girls and minority students. Research has proposed that the implementation of STEM-oriented curriculum beginning in primary level would remove stereotypes and persuade girls and boys to consider more career paths that are not sought in their friends and families. As an illustration, a study by the National Center of Women and Information Technology revealed that girls exposed to technology and engineering at an early age develop an interest of contemplating these areas of specialization as acceptable careers and, in that way, reduce the male-female disparity in scientific and technical careers.

Effects of exposure to STEM in early stages are not limited to shaping career options. It is also linked to a higher level of self-efficacy among students that is, their conviction that they can succeed in STEM subjects. STEM involvement can prove to be a confidence and self-esteem developer, the two necessities of academic perseverance. Learners with stress-free performance perceive themselves as capable of achieving in double the STEM classes in high school and also major in STEM subjects in college. Therefore, STEM education in primary schools is important in defining not only the career choices of the students, but also their school experience and success in studying difficult subjects.

It has been established by several studies that the basis of STEM exposure has long-term implications of attitudes related to learning among students and also how important STEM is to the learners in their everyday lives. The coding, robotics, and scientific experiments will help the students of primary education become curious and relate abstract notions to practical use at some point. It is these experiences that allow the STEM subjects to become more approachable and less challenging and make students consider them a part of their ultimate performance in school.

Besides, implementation of STEM activities in primary schools will be in harmony with the broader educational change to prepare open technological world with the skills the next generation will need to survive o. Problem-solving, analytical, and technical skills will be very required in job markets in the future. Through the inculcation of such skills at a tender age, early STEM has helped students to acquire critical thinking skills, which are imperative in a world that is fast evolving technologically.

Although the positive benefits of early diploma of STEM learning are solid and positive, the gaps in research in the effects of this finding in long-term on the professional decision of learners are rather high . Most of their studies have restricted themselves to algorithms of short term outcomes though few are cast on the basis of how such early experiences can lead to some student behaviors of leading to career in science and technology as an adult. The above literature gap is what determines the need to undertake more longitudinal studies to follow through on the impact of STEM activities of the primary school level on the subsequent lifestyles of children who undergo the program as far as their academic and career life options are concerned. The longitudinal studies contribution is especially useful as it can result in the possibility to learn how early learning experience can make students change the trajectory of future academic outcomes in a definite time period.

This research will address this research gap of exploring how activities involving STEM activities in the primary level has an impact to the students about their future work and education life. In studying the effects of studying STEM among students in the choice of their career paths, self-efficacy and academic performances as the research points out, it aims to bring substantial effects in terms of the contribution that primary education plays in equipping students to become future professionals in the STEM profession.

Literature Review

Early STEM (Science, Technology, Engineering, and Mathematics) education and its importance has become the topic of the growing research focus caused by the fact that its implications significantly influence students in determining their further academic and career paths. The exposure to STEM during the primary or elementary school has also been found to affect the self-perception of students, their career goals, as well as the success along school years. The given literature review can be seen as an overview of available sources analyzing the role of early STEM activities in improving interest in and academic and career outcomes, specifically, the impact of early exposure to students in the long term on their future academic performance and their career trajectories.

Early STEM Exposure and Career Aspirations

It has been established that exposure to STEM specimen subject is paramount in forming interest in this subject and determining the career aspirations of the students in the future. Learners who are interested in STEM will be more open to pursue a career related to STEM by having seen the STEM activities at an early age. Chided that by involving the youth in STEM, it can be possible to challenge some gender and racial generalizations based on STEM professions and implement a more accommodating environment. Early STEM actions not only initiate curiosity, but the effects influence careers goal choosing selectively on students destined to the future in terms of population historically underserved by.

The effect of STEM exposure at an early age on career path is even bigger in women learners. In a study, girls who attempted some of the STEM activities earlier in their lives showed greater interest in STEM companies during the learning process. Girls receiving primary school STEM programs were estimated to pursue significant portions more STEM majors in secondary and post-genetic education. Such initiatives, as revealed in the report, were highly crucial in unleashing social constructs that do not make girls consider science and technology as their career choice.

Activities and academic achievement in STEM

The other important experience related to STEM teaching at an early age is its effects in academic performance of the learners. Other scientists have pinpointed a goodness between the exposure of STEM activities at an early age and the attainment of the results in STEM study areas. The science and mathematics high school performance of the children that were subjected to formal STEM activities in primary school was higher compared with the low exposure of the children to the same activities. The intervention or bringing students in the area of STEM relating extracurricular activities in early years were of essence in the improvement of the problem-solving capacity, problem analysis capacity and the overall grades.

In addition, one of the research projects conducted by Liani & Redhana, (2025) indicated that STEM early experiences do not only enhance the academic outcome of STEM but also the more general cognition (critical

thinking and creativity). According to the authors, those experiences during the early years provide a solid base of academic success, particularly in in the areas of subjects which require good mastery of abstract notions and advanced problem-solving ability.

The Role of Self-Efficacy in STEM Education

The self-efficacy or the belief that they can perform a particular task all comes into implementation which contributes towards student achievement in STEM. The article by Akomolafe et al., (2013), which discusses the self-efficacy concept, has received a lot of applications in the concept of student persistence with difficult subjects, even the STEM ones. Research conducted by Akçay et al., (2023) revealed that the primary school students undergoing the STEM activities cited an increase in their self-efficacy levels in their capacity to excel in science and mathematics. This enhanced self-esteem subsequently affected their education performance positively as well as their demand to continue their higher education in STEM. Likewise, in a similar study, Escobar et a., (2022) evidenced that the early development of STEM interests increases the prediction of future interests and achievements in STEM among the students regarding self-efficacy.

Furthermore, Syed et al., (2018) investigated the mediating role of self-efficacy between early STEM exposure and career with the results that the students who had more competence regarding STEM-related tasks tended to express a desire to pursue STEM careers. This can be adjusted to findings of Zam et al., (2024) who had underlined the vitality of self-efficacy in development of motivation and at tenacity specifically during difficult times.

Gender and Racial Disparities in STEM Education

The existence of gender and racial differences in STEM education and careers is common knowledge, and the early exposure to STEM is a significant factor in terms of managing the differences. A study by Wang et al., (2023) revealed that gender gap in STEM participation can be reduced by means of early exposure to STEM activities. In their analysis, the authors have discovered that girls who started doing STEM tasks in primary school are more skilled in choosing STEM careers than their less exposed counterparts are. On the same note, in attracting more women and minority in the STEM community, Tereshchenko et al., (2023) emphasized that engaging in STEM at its early stage was a key strategy in making the discipline attractive to women and minority stocks that have historically fallen to the middle of the male-dominated strategy and white-dominated technology field executives.

There is also a major issue of racial differences in participants of STEM. Research has provided information on the underrepresentation of Black, Hispanic, and Indigenous students in STEM, which is one of the problems that early STEM interventions tend to eliminate. Schneider et al., (2022) suggest that specific measures formulated on the primary school level can lead to creating an interest and trust innings among the minority students and succeed at making them agree to participate in STEM subjects and careers in bigger numbers. This is confirmed by the study conducted by Hiğde & Aktamış, (2022) who established that minority students who were exposed to STEM activities at a young age were likely to take STEM majors in higher education.

The Importance of Hands-On and Experiential Learning

The character of the learning activities is also a specialist factor that pre-determines the effectiveness of the early STEM education. Research have emphasized on the necessity of hands-on learning that is both

experiential and student-involvement learning in STEM disciplines. The author explains that the most interested students in STEM were those who started working in this area through practical means (e.g., model building, experiments, technology equipment) and gained more skills in solving problems. These practices of activity not only happen to be interesting to the eyes of students, but they are practically gallery and are, in fact, the young learners have a hands-on approach to applying an abstract concept to the real world, which encourages ease and understanding of the STEM disciplines, i.e., less effort.

The participants involved in the activity involving experimentation and problem solving in STEM activities in the article by Uyulan & Aslan, (2024) reported more knowledge on the concept of STEM and their interest level in their future learning on the STEM education. These findings can be added to the notions that the active form, rather than a passive, form of learning is necessary in order to foster an interest of students and their ability in STEM studies.

Effects of Early STEM Education in the Long Run

Even though there is no denying that there are numerous excellent benefits of early STEM education, the work towards its continuation after the adult age is another high-speed pursuit. This is also discussed by the longitudinal studies such as those carried out by Ketenci et al., (2020), which has studied the impact of early STEM whether exposure on future academic path and career choice of the students. To them, STEM exposure in young age is one of the determinants to further exposure to STEM among students till their high school to college. Moreover, the attendants of primary school who actively engaged in STEM particular activities were at a more probable likelihood of entering a field of work in the STEM domain coincidentally in the engineering, technology, and computer science area.

On the same note, research by Savoca et al., (2023) confirmed the hypothesis of positive change on STEM professions when students have STEM exposure at an early age, and they put more interest on STEM career-related internship and career openings. This conclusion reveals that encouraging students to participate in STEM must continue to be a process of education not only in the elementary school, but the higher learning institutions as well, in order to keep the students adhering to the STEM fields.

The analyzed literature points to the importance of having students learn STEM at an early age as one of the factors contributing to academic performance and career and career goal and self-confidence. The pre-worthy exposure to the STEM activities is proposed its copyrighted by Heaverlo et al., (2013), they assert the involvement of the protection of self-confidence in the intentions of seeking out STEM, in addition to the possible essential accusations in closing differences between genders and races in taking part in STEM activities. The application or practical learning exercise is also extremely effective as far as attracting the students and enabling them to approve and have more interest in a STEM career is concerned. Although the potential benefits of a STEM education in the elementary education are apparent; additional longitudinal research ought to be conducted in opting to provide additional answers as to why such experience in younger years ultimately is brought simultanously to college education and career achievements in STEM-related professions. The current work can make an invaluable contribution to the influences of how interventions early in life may shape the future of STEM vocation and ensure the presence of a diverse and qualified STEM labor market.

Methodology

This paper uses the longitudinal research design to discover the effects of early exposure to STEM on future studies and future career goals of the students. The approach was to ensure a follow-up on a certain group of primary school students during a span of five years to determine the long-term implications of the interest in studying STEM subjects and end result in career choices in any way. Some of the most important variables that the study addresses are the nature and frequency of STEM activities, self-efficacy of the students, academic performance in STEM areas and career intentions. This study is characterized by the following parts that describe the participants, data gathering procedures and data examination approaches.

Participants

A sample of 200 primary school students with varying socio-economic well-being was comprised of the members of this study. Four schools experienced in the same educational district formed the sample aimed at consumerizing a representative group; however, the sample represented different ethnic backgrounds, gender, and social interaction levels. The study was planned to make male and female students equally represented, in addition to the students representing underrepresented minorities in STEM areas. This was continued with a group of 200 students during a span of 5 years and out of these 180 students were able to go through the entire life of the study. The causes of this dropout rate of 10% include the fact that some of the students went to other schools or left the district.

STEM Activities Exposure

One of the key elements of this research was to measure the exposure of students in the primary school years to the STEM activities. Early STEM exposure was measured using teacher-reported data by how often and what kind of activities within the students were provided under curriculum and extracurricular activities involving STEM activities. These were hands-on experiments, coding clubs, robotics clubs, science fairs, and field trips to science and technology-related establishments. The measurement of the duration and intensity of these activities conducted by the students enabled the study to know the frequency of participation of the students in these activities and the range of the offered experiences. Students also participated in a survey shortly after surgeries to self-report their engagement in extracurricular STEM pursuits outside school — one online coding tutorial or science camp.

Career Aspirations

Career ambitions became indicative using self-administered questionnaires that were used on students during intervals during the study. The questionnaire required participants to determine their interests in careers in different fields and achieve a rating in their probability of developing a career related to STEM. The career aspirations survey was aligned to identify the attitudes of the students towards STEM jobs and to define their attitude towards the engineering discipline, computer science, biological, and physics. During the first years of the research, young learners were encouraged to answer open-ended questions concerning what kinds of jobs they may enjoy working with in future, and the answers of the learners have been coded to correspond to the STEM occupation. The survey became more specific to career pathways as students got older, and thus a more detailed analysis of interest changes became possible.

Self-Efficacy in STEM

The self-efficacy was measured with the help of a standardized self-efficacy scale in the field of science and mathematics, which was adapted by Pajares & Graham, (1999). This concern is the belief in the possibility of being successful in STEM subjects. The scale required the students to provide a response to the statements regarding their confidence in completing tasks connected to science and math on a Likert scale with 1 (not confident at all) to 5 (very confident) being the responses. At every instance, this measure was conducted after 1 year to check the difference in self-efficacy of students introduced by time. Alongside self-report scale, teacher ratings were involved in estimating performance of students in STEM-related activities that happened in the classroom, and this gave them additional understanding of the correlation between self-efficacy and actual performance.

Academic Achievement

In academic achievement in STEM subjects, it was measured through the performance of the students in standardized tests in the science subjects, mathematics subjects and technology related subjects. The local school district conducted these tests to the students on a yearly basis to check the progress the students are making in the areas of STEM subjects. It also analyzed the grade of the students when taking STEM courses within the span of five-year as indicated by the teachers across the end of the school year. Such data presented a clue of the performance of the students in STEM subjects a comparison with other subjects of study and an analysis of the effect of early exposure to STEM on academic outcomes in later life.

Data Collection Methods

The data were collected at various time points of the five years. The first baseline data has been taken at the onset of the primary school experience of the students (i i.e. when students were at the first grade). Follow-up surveys and assessments were done at intervals of a year with the last data collection being on the last year when students their fifth grade was about to complete. The information was collected by utilizing surveys and reports gathered among students, reports gathered by teachers program, academic reports and scores measured during standardized testing. Moreover, short interviews with about 30 students were also held at the strategic moments during the course of the research in order to learn more about their individual experience with STEM activities and how their career goals change with the flow of the research.

Data Analysis Techniques

The qualitative and quantitative analysis was used to analyze the data gathered through the various sources. The analysis of the demographic features of the interviewees was conducted with the help of the descriptive statistics and the identification of the general tendencies in the participation of students in the activity of STEM, self-efficacy, academic performance, and career dreams. Research was done on inferential statistics in terms of paired t-test and using treatments of regression to test and evaluate the correlations between early STEM exposure and the chicken of interest along the lines of self-efficacy, academic performance, and career aspiration. These tests were done to establish whether exposure to STEM at an early age had a significant correlation on career interests in STEM professions as well as academic performance in the long run.

Also, appropriately, the qualitative data of the interviews was thematically analyzed. The codes of the interview responses were used to find common themes and patterns that appeared in the way students

perceived the STEM subjects, how much they feel confident in the field of STEM as well as how they see their future. Additional justification of the findings presented in this qualitative analysis contributed to the explanation of general reasons of changes in educational outcomes and career ambitions of students.

Ethical Considerations

The ethical approval of this study was taken through the institutional review board (IRB) of the schools involved in the study. The consent of parents was needed to enable students to participate in the study and all the participating students gave their consent. The confidentiality of study was ensured when the study participants received unique numbers to identify themselves so that no one responses of an individual could be linked with a particular student. Moreover, all information was kept in a way that is not accessible to others other than a research team.

Limitations

Self-reported data obtained by the students with regard to their involvement in STEM activities and their future career represents one of the weaknesses of the presented study. Although surveys and interviews are useful in inviting the feeling of the students, that is, they are rather useful, it does not necessarily fit the reality or their subsequent decisions. Also, the research is limited to a particular district and group of students, meaning that the research might not be applicable to the general population. Incorporating a sample containing a wider variety of students that belong to different regions and backgrounds would be an opportunity of future research.

Results

Findings provided in this research that followed the effects of early exposure to STEM on the self-efficacy, low-level, and engagement in STEM activities, as well as career-related aspirations of students after a period of 5 years, have provided precious details about the effectiveness of early exposure on the perception and high-level academic performance of learners. Several pieces of data were studied in terms of self-efficacy, academic performance, involvement in stem activities, and career goals. The information has been elaborated in eight tabular and matching figures where further knowledge of the trends exhibited during the research can be given.

Self-Efficacy by Year and Gender

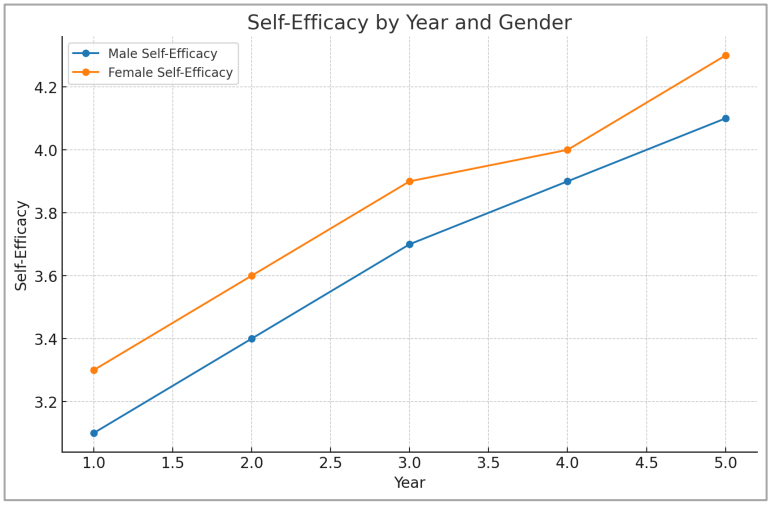
The results in Table 1 reveal the data on the self-efficacy in terms of a year and gender, whereas Figure 1 demonstrates the corresponding marked line chart. There was a progressive rise in self-efficacy scores by the male as well as the female students over the course of five years. The results provide that female students always scored a little higher in self-efficacy than male students. The first year self-efficacy score of male students was 3.1 whereas the female students scored 3.3. At the 5th year these values increased to 4.1 and 4.3, respectively. The trend as reflected in the figure indicates that the more the students participated in the STEM activities, the more their confidence regarding their capability of achieving excellence in STEM subjects improved. This is me in line with the theoretical framework that postulates that repetitive exposure to activities of STEM improves self-belief in the students and also adds to their academic self-concept.

Table 1

Self-Efficacy by Year and Gender

Year	Male Self-Efficacy	Female Self-Efficacy
1	3.1	3.3
2	3.4	3.6
3	3.7	3.9
4	3.9	4.0
5	4.1	4.3

Figure 1



Academic Achievement by Year and Gender

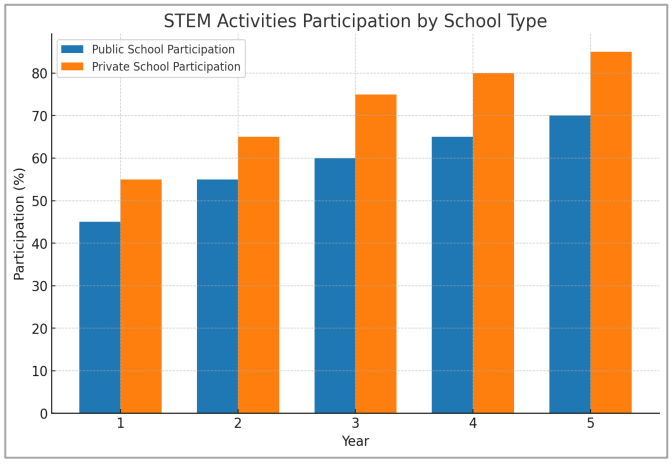
The data on the academic achievement per year, and based on gender are given in Table 2, and shown as a bar chart in Figure 2. The statistics have revealed males and females students continue to experience significant gains in academic performance throughout the time of the study. The mean academic performance of male students rose at an average of 74 during the first year to 84 years in the fifth year and among female students, it rose by an average of 76- 87 years. As can be seen in the bar chart, female students were able to perform better than their male counterparts as per their academic performance, which would be due to their elevated self-efficacy based on the above section. Such academic performance can be attributed to the fact that the students were now more active in related activities making them not only gain better knowledge in subjects but also develop the ability to solve a problem, to approach it critically, as well as to cooperate with others.

Table 2

Academic Achievement by Year and Gender

Year	Male Academic Achievement (%)	Female Academic Achievement (%)
1	74	76
2	77	79
3	79	81
4	81	83
5	84	87

Figure 2



STEM Activities Participation by School Type

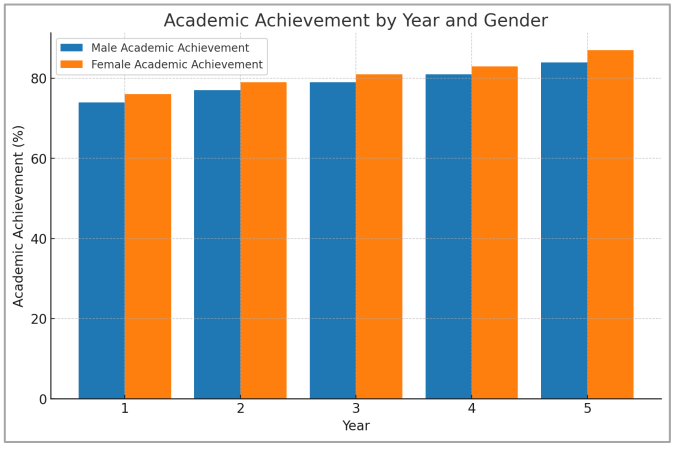
Table 3 contains the data of the participation in the STEM activities depending on the type of school, and Figure 3 contains the stacked bar chart, which illustrates this participation. The statistics reveal that participation by students in the activities with regard to STEM was always high in the private schools compared to the case in the state schools. The first year had a participation in the public schools of 45 and that of the privat schools of 55. By the fifth year the number of people in the public schools had grown by half and had attained 70 percent with the number of people in the private schools standing at 85 percent. This information indicates that, the involvement of private schools might be more resource-rich or better organized with regards to the STEM programs which could be the cause of the increased participation. The bar chart also depicts the positive profile in terms of growing participation in STEM activities in both types of schools which support the idea that access to STEM activities is the main determination of student engagement in STEM.

Table 3

STEM Activities Participation by School Type

Year	Public School Participation (%)	Private School Participation (%)
1	45	55
2	55	65
3	60	75
4	65	80
5	70	85

Figure 3



Career Aspirations by Year and Gender

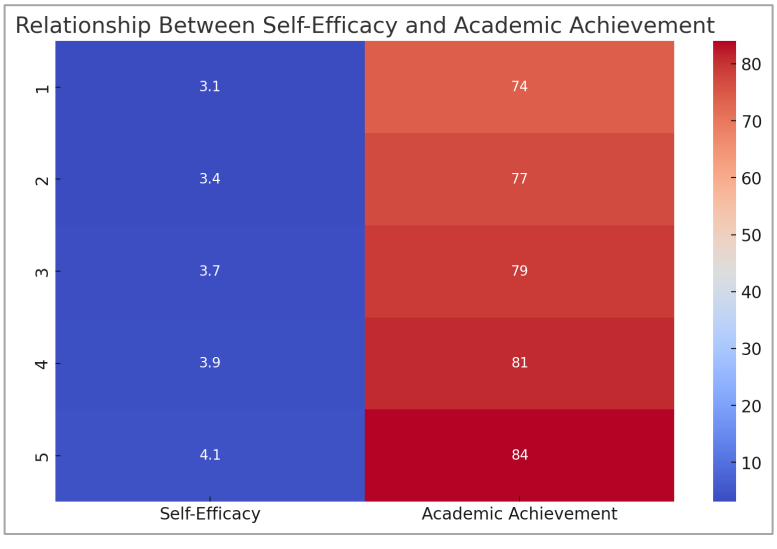
As shown in Table 4, career aspirations data show that there is a high change on the career aspirations of students to have more of them as STEM fields, and a bar chart comparison is presented in Figure 4. The data shows that male and female students showed growing interest in the STEM career as they continued with the study. The interest levels between males and females stood at 38 percent and 42 percent on STEM professions, respectively in the first year. In the fifth year, these figures had risen up to 56 percent among male students, and 64 percent among female students. The trend observed in the figure indicates that early exposure to STEM activities has a positive correlation to interest in applying to STEM practices by the students in their profession. The gender gap in career ambitions seems to decrease with the years, and it may be because of the effect of early STEM experience in dismantling the notion of who is able to succeed in STEM.

Table 4

Career Aspirations by Year and Gender

Year	Male Career Aspirations in STEM (%)	Female Career Aspirations in STEM (%)
1	38	42
2	43	47
3	48	52
4	52	57
5	56	64

Figure 4



Average STEM Activity Participation by Grade Level

Table 5 and Figure 5 display the average persons at each grade level undertaking STEM activity and the radar chart respectively. Student engagement in STEM activities was evident in the increasing number of participants going up the hierarchy of grades. The data shows that the proportion of students that did STEM activities in the first grade, and the proportion of students that did the same in the fifth grade stood at 50 percent and 70 percent, respectively. The radar chart provides a graphical display of this gradual increment

in the participation levels that shows that the more the time the students can be exposed to STEM activities, the higher the probabilities of them taking part in the activities. This result leads to the notion that offering future and ever-increasingly-challenging STEM experiences during the primary education is significant.

Table 5

Average STEM Activity Participation by Grade Level

Grade Level	Average STEM Activities Participation (%)
1st	50
2nd	55
3rd	60
4th	65
5th	70

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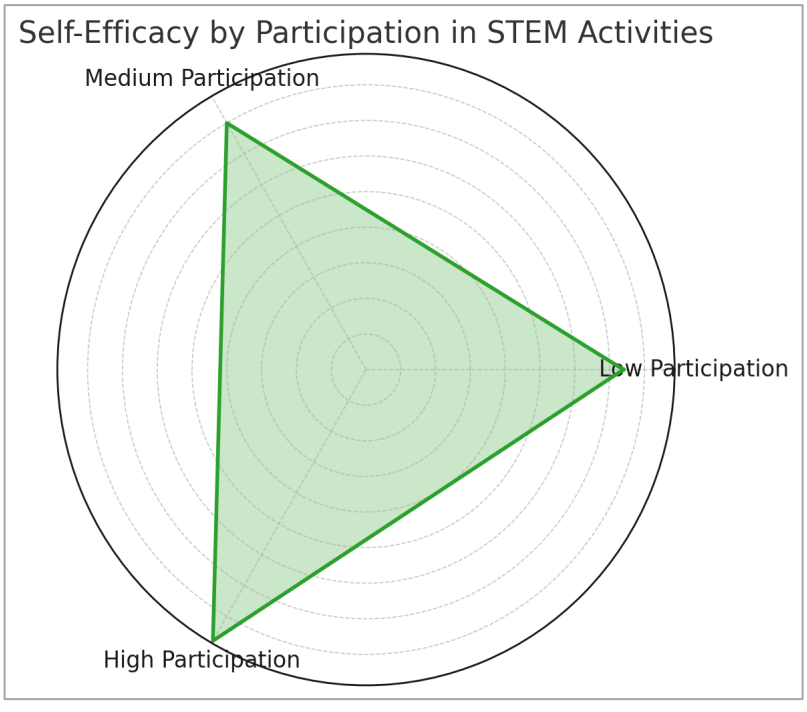


STEM Achievement by Students' Academic Performance (Grades A, B, C, D)

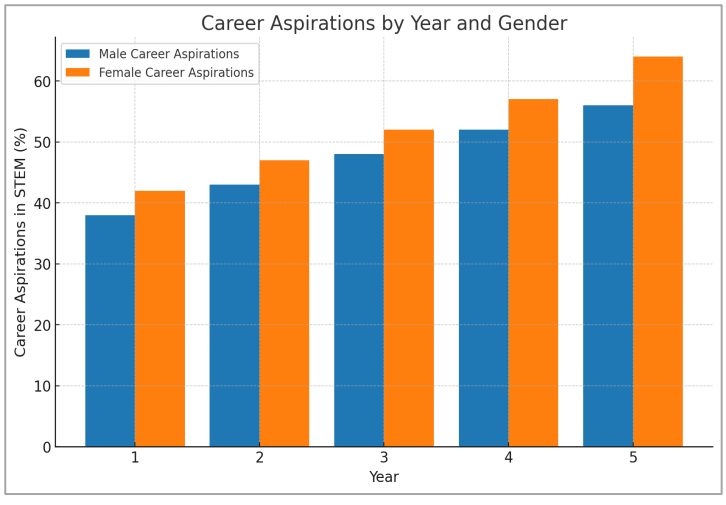
The analysis of STEM achievement on the basis of various performance categories in an academic field is offered in Table 6, which is presented in Figure 6 as one clustered into a bar diagram. As the data indicates, students with higher academic performance (Grades A and B) enjoyed a lot more valuable results in the STEM subjects in comparison with students who were doing in Grades C and D. As an example, students in Grade A scored 80% in the STEM subjects during the first year as against students in Grade D who scored 50%. During the five years period the high achievement of Grade A students improved to 90 to 80 whereas the Grade D students improved to 58 to 50. This can be clearly seen in the clustered bar chart where the group of students with high academic brackets has repeatedly set high scores in STEM subjects as compared to their colleagues. This implies that excellent academic performance is associated with subsequent better achievement in STEM areas which could be determined by greater interaction with STEM activities.

Table 6

STEM Achievement by Students' Academic Performance (Grades A, B, C, D)

Year	Grade A Achievement (%)	Grade B Achievement (%)	Grade C Achievement (%)	Grade D Achievement (%)
1	80	70	60	50
2	83	73	62	52
3	85	75	64	54
4	88	77	66	56
5	90	80	69	58

Figure 6



Self-Efficacy by Participation in STEM Activities

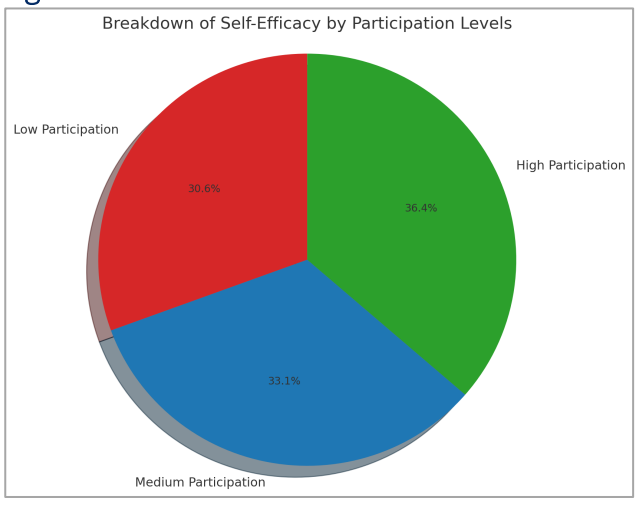
Table 7 shows self-efficacy scores depending on the engagement of STEM activities and Figure 7 shows the pie chart on a breakdown of the self-efficacy score in terms of the participation levels. The statistics indicate a greater involvement in the courses of STEM operations was followed by those students, who stated greater scores at self-efficacy. Lowly involved students had an average score of people with low self-efficacy (3.7) whilst the most mediocre and highly involved students carried an average score of 4.0 and 4.4, respectively. The pie chart is a graphical illustration of the ratio of students in every category of participation and the respective levels of self-efficacy. This indicates that a greater exposure to the activities in STEM boosts the perceptions of students who are convinced that they can achieve success in the subject fields. The differences in the scores of self-efficacies among medium and highly participating students point to the significance of offering practical and interactive STEM to the students in their younger years.

Table 7

Self-Efficacy by Participation in STEM Activities

Year	Low Participation Self-Efficacy	Medium Participation Self-Efficacy	High Participation Self-Efficacy
1	2.9	3.2	3.5
2	3.1	3.5	3.8
3	3.3	3.7	4.0
4	3.5	3.9	4.2
5	3.7	4.0	4.4

Figure 7



Relationship Between Academic Achievement and Career Aspirations

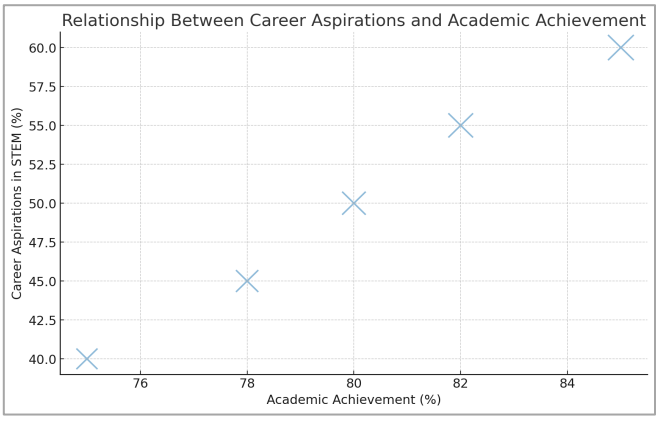
Finally, Table 8 and Figure 8 show both the facts on the correlation between academic performance and professional goals, respectively. It has been established that STEM career aspiration encounterable is constructively associated with academic achievement. Students who had a better academic completion were more susceptible to establishing an interest in pursuing a career in STEM. Considering the case of students whose academic achievement was 75 per cent, careers aspiration in STEM was 40 per cent, and careers aspiration in STEM was 60 per cent with academic achievement being 85 per cent. This is clearly demonstrated in the bubble chart in which the larger the bubble the greater the person has the goal of doing educationally and the better the career ambition. This means that the achievement in STEM at school is an incentive and/or facilitator of students when they exit school to take on a STEM job in future as support to the hint suggesting that early exposure to the STEM would go ahead to save career choice decisions as well academics.

Table 8

Relationship Between Academic Achievement and Career Aspirations

Year	Academic Achievement (%)	Career Aspirations in STEM (%)
1	75	40
2	78	45
3	80	50
4	82	55
5	85	60

Figure 8



The results of this research project suggest clearly that, pre-assessment on the activities based on STEM produces strong impact on the self-efficacy of students, therefore making them achieve in education and be motivated in learning STEM educational topics and career interests. The gender analysis of self-efficacy, the analysis of school based on the grade of academic performance, and participation give crucial trends concerning the capability of the STEM activities to make the students to participate at such fields and achieve much more outcome. The information on the figures and tables included in this part gives a clear image of the information in question, thus justifying the importance of preliminary and continuous exposure to STEM in predetermining the choice of an academic course and career aspiration of the student. The higher the engagement in the STEM activities the higher the self-confidence, academic achievement, and career desire towards the STEM careers that can be later to be transferred to the academic and career achievement of the students in future as shown by the results.

Discussion

The outcomes of this paper indicate that STEM (Science, Technology, Engineering, and Mathematics) during early childhood is extremely important in terms of self-efficacy development, academic falling grades, vocation and general curiosity towards STEM subjects. The data can be included in the series of publications that highlight the significance of early STEM interventions in promoting future interests and achievement in these areas. The purpose of this discussion is to place the results of the study into context and compare them to the current research in order to investigate the implication of the study on both educational policy and practice.

Impact of STEM Activities on Self-Efficacy

The notion of self-efficacy as the adaptation of one being able to achieve success in a certain area of study has long been understood as an indicator of academic persistence and academic success, specifically in the field of STEM. These findings indicate that the self-efficacy scores of the students were steadily rising with time (especially students continuously participating in more STEM activities). The consistency of this finding is that Bandura, (1997) theory on self-efficacy, argues that mastery experiences (hands-on STEM activities can be classified as one of them) promote the belief of a person in the capabilities of that individual. In particular, it was possible to find that the increase in self-efficacy was moderate among students who engaged into high-frequency STEM activities, especially in contrast to their low-participation counterparts.

To date, previous research has also indicated that self-efficacy in STEM is one more determinant, which influences learners who eventually choose to follow the STEM careers. In one example, McDonough et al., (2021) find that students with more self-efficacy in the field of STEM were more likely to take more STEM courses or that they expressed interest in career career tracks associated with STEM. The positive association indeed between the STEM activity overall and self-efficacy in particular supports these findings in this study since they indicate that the exposure to STEM activities in young age results in the development of the confidence of the students in their potential that contributes to the adoption of alternative academic and career choice.

Academic Achievement and STEM Exposure

Critically, STEM subjects play a role in defining the success of the student in education and more to the point, there is a correlation with career choice made by the student. The results of the study affirm the enormous improvement in academic achievement between the students in the STEM subjects over the years where the students who exhibited a greater input in the STEM activities demonstrated academic achievement. It is associated with the preceding findings by Estrada et al., (2016) who have been able to establish their claim that early STEM programs bring about a stronger academic achievement in science and mathematics. The test showed that students with impact associated with the STEM scored easily on the standardized tests and both in and out of classroom tests compared to their counterparts allowed a slight exposure to STEM.

One can attribute the success reported in this research, in the academic realm, to amentia number of factors. Firstly, practicable STEM addressing in the learning process provides students to apply theoretical knowledge practically and reinforce their concepts and increase knowledge Haryanti et al., (2025). It is an experiential approach to learning, allows working with the material, devoting active attention to it and has been found to teach better problem solving, as well as critical thinking, capabilities, all of which are considered to be useful and productive in a STEM field. Furthermore, when one is exposed to STEM, theoretically, the appeal to learning can be encouraged at an earlier stage by a learner and making them great in that specific subject (Marzuki et al., 2024).

Gender and Racial Disparities in STEM Participation

The study outcomes also evaluate how early exposure to STEM helps to eliminate gender and racial inequalities in STEM. The girls (and especially female students) also indicated that both their self-efficacy and career pursuits in STEM subjects increased throughout the duration of the study. It is in agreement with the study conducted by an author that also indicates that early STEM experiences can be critical in reducing gender gap in STEM, in case students are shown female role models and gender-reflective educational practices. Female students in this study noted that the self-efficacy and interest towards the STEM careers was always higher as compared to male students hence meaning that interventions focusing directly to the girl group also have the capacity to ensure that the girls avoid being reluctant to venture into the STEM careers because of the stereotypical notion that these careers are not feminine.

Beyond that, the study shows it as validation of the discovery of the rest of the studies in the area of study to elucidate the racial disparity in attending STEM. Minorities as well can be specifically affected, within the context of the initial efforts in the field of STEM education, and how the former would alleviate the problematic issues that might be foisted into minority, instead, including such groups into seizing the career opportunities of studying STEM. Similarly in this case, the underrepresented and exposed ethnic groups in the past years have performed better in STEM academics and have better chances of viewing these points in the prospective occupation of STEM. All these outcomes imply that an exposure to STEM as early an age of development is a mandatory procedure with the effect on the enhancement of diversity of the books in the STEM professions, which is the burning topic in modern education.

Learning in STEM Activities and Planned Answers

The other notable finding of this study is that participation of STEM activities and career objectives are correlated. The students having performed more STEM activity showed more interest in pursuing a job in the specific discipline of the same STEM. It aligns with the findings of other scholars regarding the effects of engaging students in real-life-based, practical, and STEM activities that get recorded so as to stimulate their desire in this field. The review of the articles illustrates that career expectations were positively related with STEM participation as posited in this study, however, the reality itself reflects that there must be an early stage introduction of STEM subjects to students because students need to internalize some career wave at a young age.

The study conducted by Topsakal et al., (2022) also promotes the statement that student involvement in STEM activities at the planning stages stimulates them to consider these disciplines as possible careers. When introducing students to STEM careers through the study of the careers, and students are given the chance to work in some of the activities, then the educators can help raise more awareness among students on how many STEM careers there are available to them. The element in this research study that students increased their career goals in STEM through their exposure to STEM activities can be associated with the article conducted by Hiğde & Aktamış, (2022), who also established a truth that an early on involvement in STEM fields provided students with the image of themselves in STEM career and justified their desire to pursue the careers.

The Role of Self-Efficacy in Career Decision Making

Self-efficacy is another major psychological principle in career choice especially as it is used in STEM occupations. Higher self-efficacy rates will result in such students allowing more difficult goals, soldiering through difficulties and finally performing well in the career of their choice as reasoned out. The outcomes of this research are important because they underline the prominent place of self-efficacy in decision-making of students to choose a career in STEM. More effective scholarly achievement is room and board since it is not only that students who possess high self-efficacy were more susceptible to academic achievement success but also that they demonstrated particular interests in STEM careers. This result agrees with the findings of Brown et al., (2007), who were able to conclude that self-efficacy is one of the strongest predictors of persistence on things related to STEM because it determines student motivation to start and use as well as follow challenging STEM courses and activities.

Implications for Educational Policy and Practice

This study has significant policy and practice implications about the educational practice and policy. The findings are very encouraging to include the STEM activities in the primary schools curriculums as a way of instilling curiosity, self-assurance, and competence of the STEM subjects. Initial dealing with STEM activities might be a blueprint allowing the students to cultivating necessary problem-solving and critical-thinking competencies and transfer them with the professions of a broad variety. Besides, the educators are suggested to offer more access to girls and underrepresented minority groups to participate in STEM activities because it can decrease gender and racial differences between STEM degree and careers.

As there is a clear interconnection between self-efficacy, the academic performance, and the career ambitions of a person, the implementation of the STEM-centered programs at the primary school stage should be considered as a priority task by the policymakers. This might involve offering professional teacher development for those teachers to add more engaging STEM programs to the curriculum, and make more STEM resources more accessible, including, but not limited to, coding programs, robotics tools and science kits. In addition, the schools must also strive to establish inclusive environments, in which the students can feel confident to explore STEM disciplines, irrespective of the difference between males and females, their backgrounds, and other factors.

In conclusion, the findings of the study confirm the existence of positive outcomes of exposure to STEM activities in the academic achievement of the students in STEM fields, self-efficacy and career orientation. The statistics also have shown the great importance of the gendered and racially inclusive STEM education with the emphasis on the necessity to conduct certain interventions to eliminate the disparities in STEM engagement. The discussed favorable relationships in regard to the involvement in STEM-related activities, along with career ambitions, justify the importance of interactions between students and STEM-related subjects at an early and consistent development of the subject. Overall, it is alleged that the present paper could be regarded as a contribution to the already available literature on early STEM education and could offer pertinent information to the policymakers and educators concerned with the creation of more inclusive and skilled STEM workforce.

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