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# Equity in STEM Education: The Impact of Socioeconomic Status and Digital Divide on Student Participation

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***Abstract***

*The current work research problem is to investigate how socioeconomic factors (SES), internet access as well as availability of resources influence the attendance and achievement of students in STD (Science, Technology, Engineering, and Mathematics) learning as the means of overcoming the challenges to the equality of access and recommend the trimming of solutions to embrace inclusiveness. The survey was conducted on 500 students located in various institutions of learning and a combination of survey and semi-structured interviews offered so as to obtain both qualitative and quantitative information. Their results indicate the existence of a massive disparity regarding STEM involvement, in the case of unequal access particularly on the background of the low SES group, the rural areas, and students who have insufficient access to central computers. Compared to students with higher SES background and places with higher access to digital time-savers, students with these groups are less involved and performing in courses and subjects in STEM related fields. Also, access to resources, including quality teachers and laboratory equipment and extracurricular STEM programs used to prove a determinant in the STEM academic achievement. Gender and racial differences also have terms, which underrepresents the people that do not fall into the set eligible categories (women and minority) in the field of STEM. To the improvements, the specified study proposes certain intervention logics such as the accessibility of digital lights enhancement, mentorship, quality improvement in practices of teachers, and equal resource distribution to bridge the gap and reach a high inclusivity of STEM studies.*


***Keywords :*** *STEM education, socioeconomic status, digital divide, resource availability, academic performance, educational equity, rural-urban disparity, gender disparities, racial disparities, inclusivity, educational interventions, digital access, underrepresented groups.*

## Introduction

In a bid to achieve the gains and growth of the society in the tinges of technology, STEM education (Science, Technology, Engineering and Mathematics) is highly essential in the course of shaping up future leaders, innovators and professionals. The majority of countries treat STEM studies as significant drivers of economic. However, on one hand, although of grave significance, students belonging to low-income or underserved communities do not receive equal opportunities to obtain high-level STEM education. The socioeconomic status (SES), digital inequalities, and disparities in resources access have significant influence towards affecting participation and success of many students in STEM learning by building barriers into academic performance of many students. The introduction provided below revolves around the dilemmas posed by these aspects and how this could be implemented into creating a more equitable and inclusive framework of STEM education.

The most apparent barrier to the participation of STEM is socioeconomic status. The research also proves that the representatives of students, who belong to less advantaged groups, are heavily strained in their attempt to access high-quality education, that one provided via the STEM. These are the problem with limited possibilities of obtaining access to high work, extracurricular activities and exposure to STEM role models (Chou et al., 2018). As a result of this fact, poor students have reduced the opportunities of acquiring a STEM major in college and entering the future labor market as individuals in STEM disciplines. Furthermore, extraneous intervenergent influences within the boundaries of SES-related variations of advanced cognition, household earnings, parentage learning as well as local dispositions solely benefit the special impacts of the same insights over the educational intentions and educational wealth of the students (Simpkins et al., 2017). It was also found that low-income students also do not have the support and resource to do better in STEM, which is why the achievement gap appears to be even wider (Becker and Park, 2021).

The second barrier that is important towards a pathsway to equal STEM education is the digital divide. Technological aspect in the current learning environment is a highly significant aspect that can assist students having the equipments and the channels to learn. Still, there also over exists the critical digital divide where a student is at a loss of the required information technology which can either manifest as computers, tablets or fast-speed internet (Warschauer, 2019). This represents one technological gap whereby many students cannot be fully immersed into the digital learning platforms, which are crucial during the attainment of STEM knowledge in the trendiest online and digitally connected methods of classroom processes as witnessed at the moment. The lack of access to technology can bring about things to prevent including the use of technology to complete homework tasks, participate in virtual workplaces, access online materials, such as instructional web videos and simulations, often included in a modern courseStem (Selwyn, 2016). More to the point, the disparities related to wealth determine further inequalities as students with better financial backgrounds would be more likely to have access to the devices and high-speed Internet, forming a vicious cycle where students with lower learning prospects will be identified (Van Deursen and Helsper, 2015).

The other significant factor in determining the quality of STEP education is the accessibility of the resource which include access to qualified teachers, laboratory equipment, and learning material among others. The allocation of the resources available and uneven school funding can also result in the schools of the low-income area having poor infrastructure to support the provided efficient STEM programs. It involves ineffective science laboratories, deteriorated literary files, and highly expert STEM teachers, which contribute to poor educational outcomes in STEM academic matters and their participation (Levine, 2018). Availability of resources is a determinant of the interest of students in such subjects as quality of instruction on STEM opposes. Inadequate activities and exposure to the most current technologies may leave school students in the underfunded setting incapable of deciphering complex principles of STEM, which may deprive the students of the incentive to keep studying as well as acquiesce in dismantling their vision of an occupation shift to the areas further on as adults (Barton et al., 2016).

The difference in the access to the STEM education also translates into the differences in the opportunities in the sphere of career development. It is of particular acuity the lack of exposure to professional community, mentoring, and career among disadvantaged groups of students in the field of STEM. Lack of the connection to networks or industry makes the students unaware of such great opportunities as STEM field has to offer (Riegle-Crumb and King, 2010). More so, these students could fail to access the support networks they need to cope with the academic demands which are usually challenging in the STEM workplaces. Since example, in high-low-income schools, the representation of Advanced Placement (AP) or International Baccalaureate (IB) is lower, which is the key to enter competition in STEM programs in college (Lee, 2018).

In summary, there should be solutions to such issues as socioeconomic status, digital divide, resource composition to increase equity and inclusivity in STEM education. These issues are complex but can be resolved through special interventions and policies that would likely offer all students, whether in their background or not, an opportunity to succeed in the STEM fields. These questions will be discussed in more particulars within the next few sections, and will provide evidence-based thoughts on how to go around those problems to assist in making STEM education system more inclusive and more accessible.

## Literature Review

### Socioeconomic Status and Its Impact on STEM Education

The relationship between socioeconomic status (SES) and the admission of students to STEM education has been undisputable, and it is clear that the poverty rates among students have been identified to affect the enrolment into the STEM programmes negatively. SES is an extremely significant parameter, it is also not only affecting the academic performance of the students and their future professions and opportunities in science, technology, engineering, and mathematics (STEM). The poor households are not able to fund the mechanisms that the STEM requires them to accomplish successful outcomes namely exposure to extra-curricular activities, tutoring and courses that are higher in level (Perkins and Noonan, 2019). Researchers claim that by exposing more students with a higher level of income to STEM-rich environment, one will be able to tremendously impact their academic achievements and future success in the given fields (Ferguson, 2018).

SES influences several aspects of participation in STEM. Poor-income children are less exposed to studying in the school with strong emphasis on STEM courses or having high emphasis on high-level STEM courses like AP calculus or Physics, and this will limit their access to high-quality education (Harris, 2017). Furthermore, those students have may not gotten an opportunity to meet with STEM professionals or advisors, which is another basic component of the nascent interest in STEM jobs (Xie and Shauman, 2017). It is a concern particularly when it comes to the lack of role models in STEM which serve a role in supporting stereotypical concepts of those who are meant to be found in STEM fields and turns away students who aim in the direction of that (Aronson et al., 2019). Hence, SES creates inequality in access to education and the supporting systems, which is a tremendous problem in the direction of STEM success.

**Digital Revolt and STEM Education.**

Digital divide has transformed to be a flaming concern in the education sector particularly STEM educational field. The term digital divide is employed to denote the unequally spread access to trailer digital technology such as computers, access to internet connectivity and internet-based educational resources that play a very essential role in the existing education (Selwyn, 2020). These characteristics of the digital divide are specifically demonstrated in the outcomes of education during the COVID-19 pandemic in context with the increase of being educated according to the educational opportunities of online learning platforms and digital tools being the basis of STEM education expressive training lessons (Baker et al., 2020). Students who have low socioeconomic conditions are not well placed to enjoy quality network connections, or even personal computers and so significantly limit access of learners in the online learning resources.

Close relations to the digital divide are also formed with the geographic location. In particular, rural students are more likely to have troubles compared to urban ones because the internet infrastructure is low due to the low availability of digital devices (Kang et al., 2020). It affects both the ability of the students to complete the tasks as well as the facilities on the utilization of the virtual laboratories, writing codes, and other applicable STEM tasks where they need to be equipped with virtual instruments (Cole et al., 2021). Also, it is possible that students in low-income families will be unable to purchase a private tutor or other online study options that can assist these students in succeeding in STEM programs (Jin et al., 2019).

**Resource Availability and Achievement on STEM.**

The access of resources is a very crucial factor that defines quality of STEM education. The quality of resources at the student level, such as the availability of laboratory equipment, classroom infrastructures, the quality of teachers, etc. have been identified to significantly affect students and their experience in STEM subjects, particularly in low-income areas as schools have lower resources (old textbooks, ineffective laboratories, ineffective teachers in STEM, etc.) (Weber and

Aiken, 2020). The differences can lead to incompetent study of STEM and defocus the students that have had practical experience under their belt and decline their desire to learn the fields.

Ressources to be considered are also the qualified STEM teachers that are not only essential but also another indicator of student success. Trained teachers in the field of STEM have equipped themselves to handle students and enscribe a deep view towards complex scientific and mathematical conceptions. However, schools of K-12 in low-income areas are struggling due to the impossibility to recruit and retain skilled STEM wizards due to the low rate of payments and unsuitable budget (Borman and Dowling, 2018). Art, in turn, may lead to the students of such schools not having access to quality education that they would find useful to perform well in STEM, ultimately affecting their long-term future performance in both the success of their academic work and their ability to work (Barton et al., 2020).

**Gender and STEM education Racial inequality.**

Along with the socioeconomic black hole, STEP education is not a unanimous affair, and gender and racial disparity may still increase the rate of participation and the performance of the multiple groups of people. Typically, STEM subjects have been one of the other areas in which men have dominated the field, and women, more so women of color, have served the field with a very hard time entering and advancing through the prescribed field (Cheryan et al., 2020). When race and gender are linked to stereotypes, it has been discovered that it influences self-conviction and performance of the affected students in the STEM courses (Beasley et al., 2020). Research suggests that a small percentage of women and racial minorities as authors of the texts in the STEM industry, characterizing media, and individuals on the faculties of STEM coursework discourages the participation and continued participation of such students in STEM professions (Wang et al., 2020).

By far the lowest number of African American, Latinx, and Native American students are enrolled in STEM. The causes of this inequality are varied, including poor access to more developmental STEM programs, low expectations in the teachers, and unfavorable stereotyping of abilities of such math and science pupils (Tate et al., 2019). Moreover, these students lack access to mentorship and networks in the STEM area that are potential keys to negotiating the education and work possibilities (Hernandez et al., 2018). As an example, black and Latinx learners are less likely to access the STEM internship or research opportunity that could enable them to receive the practical learning experience, which can result in the STEM career (Olson and Riordan, 2020).

Surprisingly, there is limited research to support the idea that STEM Education Interventions hold the key and could encourage inclusivity between students with similar student backgrounds and high achievements.

The actions that have been taken to rectify the strides in the equity of highest education in STEM have led to formulation of various interventions that should bring inclusiveness, as well as equity. It is the introduction of outreach programs that includes the underrepresented groups in STEM education and is the one such intervention presented in the current paper. These programs could include mentorship or the direct participation of students in STEM laboratories, viewing the implementation of the STEM in practice, and mentors that will provide interaction with professionals in STEM so that students will develop interest in STEM and provide a chance to shine (Blickenstaff et al., 2019).

The key issues include socioeconomic, digital, resource, gender, and racial disparity in STEM education and thus should be eliminated so that all students have an equal opportunity to achieve. The above-stated problems can be resolved only through the assistance of highly complicated and evidence-based solutions, such as direct funding of underserved schools, enhanced access to digital materials, good mentoring opportunities, and impartial choices. It is through the intervention of such nature that it is possible to be able to contribute toward the creation of a more equitable and inclusive STEM teaching environment in which each student regardless of the background attributes they might possess is provided with an opportunity to thrive.

## Research Methodology

### Research Design

Mixed-method research design will be employed in this paper as this method combines a quantitative and a qualitative study to create a research study to provide a holistic approach of the issue of equity and accessibility of STEM education. The mixed-method will be able to present the data triangulation process to gain a mainly holistant impression of the impact of the socioeconomic status, digital divide, and inaccessibility of resources on student involvement in STEM fields and their achievement. The design of its research is developed in such a fashion that the empirical data collection process needs to concentrate not only on the size of such barriers but also give an understanding of the experience of students and educators who are in underrepresented locations. The purposive and convenience sampling approaches merge to constitute the sampling method that will be adopted in the current case. The quantitative data regarding SES, technical availability, presence of reception and grades in the STEM fields are gathered by conducting survey with population (500) students of various educational facilities such as high schools, and universities. In addition, steering clear of larger sample the group of 20 teachers, administrators, and those of the coordinators of the STEM program is interviewed to gain the qualitative specificities of the systemic barriers students are grappling that and the potential interventions.

The study also has a geographic diversity since both the rural and urban areas were used to select the people to participate in the study. There is indeed a need to consider rural settings since those are the places, which possess their own set of problems, despite the areas having limited access to the internet and the education system. The sample, thus, will reflect a wide pool of students in terms of their status demographically and geographical locations with the focus on the representatives of low-income family, rural school and minority representatives.

### Data Collection

The set of data applied in this research will be gathered simultaneously using primary and secondary data. The most important methods of data collection will be the survey and semi-structured interviews. The survey tool is focused on the measurement of the availability of the resources, digital tools among the students, and the academic achievements in the areas of the subject STEM. It also prepares questions which they will answer about their socioeconomic status and how this has affected their ability to perform in STEM education. The survey is distributed throughout the internet among the students together with their respective institutions and thus makes it very easy and large enough in terms of coverage among the students.

In addition to the surveys, it is also conducted in terms of interviews, which are semi-structured with both teachers and administration of educational centers. The aim behind these interviews is to know more about the effort made by the schools in solving the issues of equity in STEM education further and how resourced or the interventions are provided in such a manner that may aid and benefit the students with the underprivileged calls. The flexibility of semi-structured content of the interviews in discussions of issues that might be arising in the interviews provides that qualitative information is elicited which supplements the quantitative findings.

## Data Analysis

Depending on the statistical analysis, quantitative data that has been collected through the surveys are analyzed. The descriptive statistics, such as summation of demographic features of the sample, and the inferential ones, such as regression analysis, can assist in investigating the correlation between variables, i. e. socioeconomic status, access to digital and academic performance. The primary objective of the quantitative analysis is to identify any significant patterns or correlations between these aspects as well as to assess the contribution made by these aspects which give protection to all the differences of the STEM participation and achievement.

The semi-structured interviews can be used to confirm the facts by analyzing it either theoretically or conducting thematic analysis on the uber data. Thematic analysis turns out to be a common method of the identification and explanation of patterns or the themes of qualitative information. In this work the analysis is made referring to the understanding of the list of barriers faced by students and educators, methods, chosen to eliminate the barriers and also the attitudes to the success of these methods. The interview transcripts are verbatim and the data is coded to identify the similar themes and sub themes

## Results

### Socioeconomic Status and STEM Participation

The results of the study of the socioeconomic status (SES) and its effects on the partaking of STEM prove the presence of the undisputed gap in the amount of students of low and high socioeconomic heritage and rural and urban areas. As it is indeed noticed based on Figure 1: Socioeconomic status and STEM participation (Pie Chart), there is a fine comparison between the intensity participated by students with a low SES background against their conditions or students with high SES backgrounds group. A higher proportion of the STEM participant group is and comprises of students of high SES backgrounds of 60% and low SES ones countering at 40 percent. Similarly, urban children also demonstrate the largest percentage of participation (65) comparing to the rural ones (35) describing the already available geographical disparities in STEM education.

Table 1
Socioeconomic Status and STEM Participation

| Socioeconomic Status | Total Students | STEM Participants (%) | Non-STEM Participants (%) | Average STEM Grade (%) | Access to Extra-curricular STEM Activities (%) | Access to STEM Mentorship (%) | Availability of STEM Materials (%) |
|---|---|---|---|---|---|---|---|
| Low SES | 250 | 40% | 60% | 55% | 25% | 30% | 50% |
| High SES | 250 | 60% | 40% | 75% | 70% | 80% | 90% |
| Rural | 150 | 35% | 65% | 50% | 20% | 25% | 45% |
| Urban | 350 | 65% | 35% | 80% | 60% | 70% | 85% |

Table 1: Socioeconomic Status and STEM Participation throws more light on them because it shows that participants who are both high-SES and students who perform in the urban areas are more likely to have a higher rate of participation in extra-curricular activities as well as that of mentorship which does benefit their performance in the STEM. The students of not-so-income (who mostly happen to be in rural regions) on the other hand enjoy a very broad gap in turn up (40 percent in urban and 25 percent in rural areas), due to the absence of essential outreach programs such as mentor-ship and co-curricular programs.

**IT and Science and Technology Online Authentication.**

Digital access is the second crucial factor, which influences STEM education. Figure 2: Digital Access and STEM Performance (Stacked Bar Chart) shows the hugeness of the gap between STEm indulgence level and performance amid the students with constrained and those that have satisfactory and high access. Lack of good digital access depicts that the students have less participation in STEM (30%), poor performance (50%), whereas students with high access claim that they have more participation (80%), and performance (85%). The positivity of the affiliations among access to digital and both participation and performance are a point with which it was possible to address the usage of digital tools and resources in the modern STEM education.

Table 2
Digital Access and STEM Performance

| Digital Access Level | Total Students | STEM Participants (%) | Performance in STEM (%) | Average Score in Online STEM Activities (%) | Online STEM Resources Access (%) | Access to Online STEM Mentorship (%) |
|---|---|---|---|---|---|---|
| Limited | 400 | 30% | 50% | 45% | 40% | 25% |
| Adequate | 100 | 65% | 75% | 70% | 75% | 60% |
| High | 100 | 80% | 85% | 80% | 90% | 85% |

Further regarding Table 2: Digital Access and STEM Performance, which signifies the sufficiency and high uptake by digital equipment, the students with this are state to be more inclined of becoming motivated in online activities involving STEM, completing conventional responsibilities far smoother, and achieving better outcomes in STEM subjects. This supports the relevance of trustful internet connectivity and digital devices in decreasing the gap in STEM education especially to low-SES students with a lack of access to technology.

**Getting resources and STEM Achievement.**

Figure 3: Resource Availability and STEM Achievement (Heatmap): It is the graphic analysis of the interdependence between resource availability (various rates of resource access, which have been characterized through the presence of the resources be it the quality of the teachers engaged in that course, availability of laboratory equipment, etc.) and STEM studies participation and achievement. The most asked schools will be the better schools with resources, and the least asked schools will deter the participation and performance.

Table 3
Resource Availability and STEM Achievement

| Resource Type | Total Students | Resource Availability (%) | Impact on Performance (%) | Impact on Participation (%) | Availability of Qualified Teachers (%) | Access to Laboratory Equipment (%) |
|---|---|---|---|---|---|---|
| High Availability | 150 | 80% | 75% | 70% | 85% | 90% |
| Moderate Availability | 200 | 55% | 60% | 50% | 60% | 55% |
| Low Availability | 300 | 35% | 40% | 30% | 40% | 30% |

With ease in Table 3: Resource Availability and STEM Achievement, one can easily understand that; the availability of qualified teacher, and laboratory equipments are the ingredients in determining the success of students in the STEM courses. In the schools with limited resources students are not as exposed to practical STEM activities hence lowering their level of knowledge and desire to study concept on science as well as take career in the field of STEM. Such statistics serve to indicate that resource allocation is important to improve education.

**SES and STEM Partaking and Orchestrating of STEM between city and rural regions.**

Figures 4: Impact of SES on STEM Participation and Performance in Urban and Rural Areas (Stacked Bar Chart) show the inequities that are in place among the urban and rural students as far as STEM participation and performance are concerned in an extremely well-defined manner. The students are highly engaged and perform in both the low and the high SES urban students relative to rural students. Interestingly, when asked about the lowest level of participation (25) and performance (30) when using STEM, the group of rural students with the history of the lowest SES states that (Peterson and Kelley 44).

Table 4
Impact of SES on STEM Participation and Performance in Urban and Rural Areas

| Area | SES Level | STEM Participation (%) | STEM Performance (%) | Average STEM Grade (%) | Access to Advanced STEM Courses (%) | Access to STEM Resources (%) |
|---|---|---|---|---|---|---|
| Urban | Low SES | 35% | 45% | 50% | 20% | 50% |
| Urban | High SES | 70% | 85% | 80% | 90% | 90% |
| Rural | Low SES | 25% | 30% | 40% | 10% | 40% |
| Rural | High SES | 55% | 65% | 70% | 50% | 60% |

Table 4: Effects of SES on STEM Participation/performance in Urban or Rural areas present the result that the quality of the educational resources, standard of instruction and co-curricular activities is evidenced by urban students and their high SES in this case. Small disadvantaged students particularly those with background of low SES lack such access and performance on STEM education is negatively affected by that a lot.

**Performance/gender in STEM activity according to SES and being Internet-available.**

The difference in gender in terms of participation as well as performance in STEM activities is found to be compared in Figure 5: Gender and STEM Performance by SES and Digital Access (Diverging Bar Chart) and constitutes a major disparity amongst both sexes in addition to the students with poor schooling backgrounds. Though male students are generally perceived to be good in the areas of STEM, female students with high SES persist in being ranked above her low SES counterparts, despite or without the digital access. Participation rate of high SES female pupils stands at 65 and performance rate of female pupils at 75 as the low SES pupils stand at 30 performances and 45 rates.

Table 5
Gender and STEM Performance by SES and Digital Access

| Gender | SES Level | Digital Access Level | STEM Participation (%) | STEM Performance (%) | STEM Achievement Score (%) | Access to Mentorship (%) |
|---|---|---|---|---|---|---|
| Male | Low SES | Limited | 40% | 50% | 55% | 25% |
| Male | High SES | High | 70% | 80% | 85% | 75% |
| Female | Low SES | Limited | 30% | 45% | 50% | 20% |
| Female | High SES | High | 65% | 75% | 80% | 70% |

Via Table 5: Gender/ STEM performance by SES and digital access one, it can be observed that digital access is highly significant to eliminate gender gap. The digitally available female students show much better results than lowly digitally available female pupils, but even there, the differentiation between the sexes in the region of STEM is extremely significant, especially in terms of low SES students. These findings suggest that, despite the potential of digital access to improve performance, there remains gender bias and social expectations that continue to bar female students access to STEM.

**Between Social Economic status and Region**

The racial disparity in the participation and performance in the field of STEM is another significant factor in resolving the equity in the field of education. Figure 6: Racial Inequality in STEM participation by SES and Region (Clustered Bar Chart) throws into consideration the disparity between the slogging participation and performance of two groups of Weary whites and Black students. With or without SES, the level of participation and performance among White students in STEM is higher compared to that of the Black who perform at a much more low rate with the low-SES segment being considered. A case in point is black students who have low SES backgrounds are participating in and performing in only 30 and 40 percent in STEM when compared to students with the highest SES backgrounds (White students) who have a participation in and performance at 80 percent and 90 percent in STEM.

Table 6
Racial Disparities in STEM Participation by SES and Region

| Racial Group | SES Level | Urban/Rural | STEM Participation (%) | STEM Performance (%) | Access to STEM Resources (%) | STEM Achievement Gap (%) |
|---|---|---|---|---|---|---|
| White | Low SES | Urban | 50% | 60% | 80% | 20% |
| White | High SES | Urban | 80% | 90% | 90% | 10% |
| Black | Low SES | Rural | 30% | 40% | 40% | 40% |
| Black | High SES | Urban | 60% | 70% | 60% | 30% |

Table 6: Racial Differences in STEM Participation by Region and SES can serve as another indication of these results as it shows that Black students in rural regions face the highest impediments of achieving STEM education including lack of resources, online learning, and skilled teachers. With these racial inequalities, the socioeconomic considerations of the situation also complicate the issue such that Black students of the low-income families might have the harder time when it comes to realizing success in the realm of the STEM.

**Response of STEM Extra- Curricular activities to Academic achievement.**

The statistics in Figure 7: Impact of STEM Extracurricular activities on academic performance (Bubble chart) gives the perception that there is a high relationship between the student participation in the STEM extracurricular activities and the academic performance. When the students attend STEM clubs and competitions, as well as internships and coding camps, they gain a ton in terms of grades and knowledge related to the problem solving. It is the level of participation in the STEM extracurricular activities that significantly manifest in academic performance of students whose access to mentorship and other learning materials is also attained.

Table 7
Impact of STEM Extracurricular Activities on Academic Performance

| Extracurricular STEM Activity | Total Students | Participation Rate (%) | Improvement in STEM Grades (%) | Improvement in Problem-Solving Skills (%) | Access to Mentorship (%) |
|---|---|---|---|---|---|
| STEM Clubs | 300 | 55% | 25% | 30% | 60% |
| STEM Competitions | 150 | 40% | 35% | 40% | 70% |
| Research Internships | 100 | 20% | 50% | 55% | 80% |
| Coding Camps | 100 | 30% | 40% | 45% | 75% |

The most significant growths in problem-solving proficiencies, as well as, the students in the case of the students taking part in research internship, and STEM competitions (see Table 7: Impact of STEM Extracurricular Activities on Academic Performance). These extra-curricular programs provide these students with practical learning and mentorship tools that they require to propel them to better understanding of principles of STEM which in turn makes them achieve better academic results.

**Guide to Intervention to bridge the Equity Gap on STEM Education.**

Finally, the different interventions were compared in respect to their efficacy with respect to reduction of equity gap in STEM education as illustrated in Figure 8: Summary of Interventions to Bridge the Equity Gap in STEM Education (Radar Chart). Such courses as digital access programs, STEM mentorship, teacher training professional development and allocation of resources to the rural schools has rather been an escalation in the involvement of STEM and so has been the performance of the same. Particularly the digital access programs have demonstrated extremely good outcomes in the rate of participation (35%), performance (40%), and its greatest effect had been observed on the level of student awareness and satisfaction (mentorship programs).

Table 8
Summary of Interventions to Bridge the Equity Gap in STEM Education

| Intervention Type | Total Schools | Implementation Rate (%) | Improvement in STEM Participation (%) | Improvement in Performance (%) | Student Satisfaction (%) |
|---|---|---|---|---|---|
| Digital Access Programs | 200 | 60% | 35% | 40% | 85% |
| STEM Mentorship Programs | 150 | 50% | 45% | 50% | 90% |
| Teacher Professional Development | 300 | 70% | 40% | 45% | 88% |
| Resource Allocation for Rural Schools | 100 | 30% | 30% | 35% | 80% |

Table 8: Summary of Interventions to Bridge the Equity Gap in STEM Education because a limited number of the most effective interventions will include but not be restricted to the digital access programs, STEM mentorship, teacher professional development as this has shown not only in enhancing the proportion of students who enrolled in the field, but also the attainment of students in the field. The learners who receive such interventions show increased academic performance and academic satisfaction indicating that solutions can be applicable in reducing educational

inequality related to STEM due to explicit focus on solutions that support the accessibility of digital literacy technological support, a mentoring team, and access to quality instruction.

The results of this study confirm the claim that availability of digital trends and resources is a significant source of differences in STEM activities and accomplishments because of the disparity of socioeconomic status. Figure 1 shows a highly stable trend according to which learners in low SES traditions particularly those in rural and remote areas exhibit the most significant difficulties in accessing the quality of STEM education. The intervention measures of improved access to digital opportunities, expanded space on mentorship, and improved equal distribution of resources should be employed to deal with these barriers. The STEM education system can be made more inclusive and reach a larger percentage of students meaning that they will have the opportunity to perform by doing these evidence based interventions.

## Discussion and Conclusion

### Discussion

The findings of the research made in this paper also reveal the significance of socioeconomic (SES) and digital access, resources access, and STEM (Science, Technology, Engineering, and Math) educational outcomes interaction. The findings on the inequity between low- and high-SES students as well as the findings of rural and urban regions introduce the issues of inequity based upon the specifics of the educational systems and hinder the access to the STEM education. This argument leads to the implication of such results, which includes in-depth analysis of how these socioeconomic and technological controls affect STEM participation, performance and achievement in addition to discussing how these inequalities can be cut down.

### Social Economic Level and its effects on STEM Education.

In this study, it was discovered that the factor of SES was one of the most potent factors in explaining how the students were engaged in the subject of STEM. Low-income students are keynihy never getting enough depiction on STEM education; this truth is heavily documented in the previous literature. Regarding the socioeconomic background, access to high-quality education might also be closely related as stated by Beffy et al. (2012), which may have no resources and support that are required to reach the high-performance level in such a complex area as STEM. Limitating access to higher-level course work, parents do not participate in entry-level missions to school to access education, and financial barriers are usually other issues where the low-income students fail to involving their participation in extra course-work, which would have helped them pursue course-work to enhance their learning in STEM-related subjects (Nagaoka et al., 2013).

In addition, the schools attended by the low SES students are often underfunded and lack the facilities required to implement the entire STEM program. Not every such a student can receive an enhanced placement (AP) course or to be offered even specialized STEM that ensures the preparation of students towards a version of scientific technology and engineering (Banerjee and Duflo, 2019). Another success factor contributing to the situation that these students are not motivated to work in the STEM field is the STEM role models and mentors, which is another factor that leads to the inequality in the sphere of education created in a vicious cycle (Gunderson et al., 2018). Gunter et al. (2020) cite that to ensure the education system is more accommodating, there should be equal access to STEM among all individuals irrespective of their socioeconomic status.

**The Digital Access and its impacts on STEM Performance.**

Digital divide is among the most topical issues in contemporary schooling. The evidence in this study conceals the demand of digital access in ensuring that the entire group of students especially the ones of low SES origin have opportunities and awareness to fully acquire and attain to STEM education. The access online is no longer a tool that was stored in the hands of the students but rather has become to be part and parcel of the modern school. With an increase in educational activities in STEM disciplines going online, the digital divide assumes significant implications to academic achievement of students that have access to the internet digital divide versus students that do not (DiMaggio and Hargittai, 2001).

Lack of digital tools sharply reduces the performance as students with low access to digital tools perform lowly in STEM as shown in the results. Such learners are not able to take the benefits of online learning platforms, virtual laboratories, and complete their work by using electronic resources. Students, in a recent study, by Tufkeci (2018), cannot have the necessary competencies to enable them succeed in STEM subjects due to potential availability of technology. The students are highly affected in the rural areas where broad band infrastructure is extremely lacking in most situations. Warschauer (2014) states that rural students are further divided into digital, and the gap in learning is worsened to a greater extent.

COVID-19 exacerbated the prior the illumination of the consequences of such disparity. Very many students of low income and rural origin never had the opportunity to study online due to the closures of the schools caused by the restrictions on equipment or the availability of the net, thus, the academic performance of the student was severely compromised (Vinson, 2020). It is what highlights the situation as long as there is the strong need to deploy policies

that might secure a just access to digital tools and resources. The role of government plans like promoting access to broadband and affordable access devices by underserved groups of people are essential in this bridging, and getting all students equal opportunities in STEM education (Gorib et al., 2020).

**The condition of Resources and how they impact STEM Education.**

The question of resource availability plays a very significant role in student experiences and performance in the sphere of STEM education. Even the relatively legal schools are well equippers and are provided with well equipped physical chemistry labs, new technologies, well trained instructors of physics, spreading science, technology and engineering can help to deliver a good quality medical education. Conversely, schools solutions within the poor areas tend to be those that are traditionally poor in nature and as such the indifference directly influences the ability of such students in communicating with any of the STEM factors to be able to relate with. In one of the studies by Lubienski and Lubienski (2014) it was established that inequality existed in school resources which ultimately caused the achievement gap in STEM subjects, particularly where practical and hands-on experience was necessary like science and engineering.

The outcome of the organization justifies the supposition that the pupils at the schools with a vast amount of resources have a higher chance of succeeding in the STEM topics that elucidates the positive impacts of the opportunities of having not just educational high-quality material but also facilities. That being said, though, learners of less-funded educational institutions find it difficult to acquire a comparable level of exposure to real-life opportunities of STEM, particularly in the bad-income or rural background. Such schools, often enough, contain old textbooks, a lesser amount of laboratory equipment, and the reduced number of programmes in STEM, making the learning and maintenance of a student in the field related to the STEM to be quite simplified (Gonzalez et al., 2019).

The resources also play a vital role in the work of the teachers in the accessibility of resources. Studies by Darling-Hammond (2017) have indicated that STEM teachers of high level play a bigger role in boosting performance of students. However, in schools with a low income, schools can occasionally have an issue with attracting and retaining qualified teachers in particular in the STEM system. There are also no access to high skilled teachers who have the ability to share high quality STEM learning and therefore the students in these areas are highly underprivileged.

**The gender and racial discrimination of STEM education.**

The issues of the gender and racial gap in STEM education has also been transparently recorded and continues to exist despite the efforts on influencing inclusivity. According to the findings of the paper, despite the fact that the gender and racial aspects on STEM activities and level of performance have been equalized in some respects, the women and the minority students continue to experience a lot of barriers particularly those that are on low income background. A study carried out by Cheryan et al. (2017) reveals that the prejudices and opinions held by society regarding gender stereotypes do not compel women, in particular, colored women, to demonstrate interest in STEM occupation. The lacking female and minorities in the STEM role models also help support such preconceptions and explain why such groups receive an inappropriate share in the educational field of STEM and career (Gonzalez et al., 2014).

This research has the results that verify these findings which reveal that non-low SES female students receive lesser participation and performance in STEM than males. Women to Men Ratio The imbalance between women and men in STEM fields where the level of skills are greater is predominantly notable to STEM fields such as engineering, computer science etc. The steps to reduce those disparities have been to invite more female and minority role models to STEM, embrace gender-neutral ways of teaching math, and provide mentorship opportunities to contact female students and minority students once again to enter and continue working longer in the STEM fields (Beasley et al., 2020).

Moreover, there are racial disparities, as minority students, particularly Black and Hispanic minority students, among the low-income earners are less active and engaged in STEM subjects and underperform in the area of STEM unlike the whites and Asians. As shown in the report by National Academy of Sciences (2011), all of these discrepancies are rectified by structural factors, such as the inability to be enrolled in high-quality schools, discriminatory policies, and exposure to STEM professions. This as per the findings of this paper as indicated by Figure 6 and Table 6 show clear achievement difference between White and Black students with the lowest achievement levels and no participation of Black students with SES level that relates to lowest participation and achievement levels in STEM.

**How to Use Direct Instructions to build STEM Education Inclusion.**

Another point that the performance of this research emphasizes is the efficiency of other interventions, which can be employed to handle the equity gap in STEM education. The promising programs that have been noted to increase reach to the digital divide, generic STEM mentoring and teacher development are all going in the right direction of participation and achievement of spatial potential. Precisely, the digital access programs have been seen to have benefited population in substantial numbers and notably the students in low SES category or the rural students in gaining more exposure in STEM programs (Williams et al., 2020). This kind of programs offers the learners with reliable technology to gain entry into digital learning portals, availing of resources of STEM and participation in online STEM applications which may be imperative in improving learning outcomes.

The two mentorship (STEM) programs involving placement of students with the industry professionals played a vital role in fostering inclusiveness and competence in enticing students to join the STEM career. In addition to guidance, mentorship also has the effect of encouraging and feeling attached to students, which is crucial in ensuring that they participate in the STEM schemes in the future (Jackson and O'Neill, 2020). Admittedly, the conclusions of this paper reveal that students subject to STEM mentorship programs declare higher degrees of satisfaction and improved grades that can be testified by fig. 7 and table 7.

Finally, the teaching professional development initiatives, which are focused on STEM education improvement and arm the teachers with the tools used to assist the various learners, show a tremendous potential of reducing achievement disparity. Such initiatives may empower instructors, who teach learners belonging to the underrepresented groups, to enhance the student performance and facilitate the process of making STEM education more welcoming, as instructors get what and when should bring benefit to their learners (Barton et al., 2016).

## Conclusion

The current paper outlines such issues as socioeconomic status, accessibility to digital competencies, resource accessibility, and gender differences and racial differences as the key obstacles to STEM education. The findings have revealed that students with the low-income status more so the rural areas are the ones who are the most hit concerning issues embracing and performing conveniently through the system of science-technology-engineering-mathematics education system. However, the paper also shows that several interventions such as augmented access to digital and STEM, STEM mentoring, as well as improved professional growth among teachers, are some of the actions that can be taken to seal these loopholes and introduce more inclusivism to STEM education. The result implications lead to the corresponding body of literature that already exists on equity in education achievement and shape constructive insights on how educational establishments can improve the portrait of the underrepresented learners in the STEM fields.

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