STEM Education Reform: Early Childhood Education Can Decrease Disparities In Education

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In the last 20 years, policy makers and educational institutions have been increasingly pushing STEM oriented material into classrooms in an attempt to improve America’s competitiveness with other countries. Unfortunately, most of these policies have seen only relative success, and predominantly only for rich, white students. Lower income and minority students have faced gaps in their success in STEM (both in school and in work) due to this divide. While the United States educational system has inherent design flaws that can’t be overcome by simple reforms, restructuring how the early childhood education system is designed can help disenfranchised students (minorities, low-income) decrease the gap in STEM participation and achievement.

Before examining methods that can be used to improve STEM education for disadvantaged students, it's important to understand the unique challenges facing them. One such challenge that many students living in high poverty or disadvantaged areas face is higher rates of student mobility. High student mobility (defined as students changing schools through a year) can have devastating impacts on student’s ability to learn. David Kerbow, a researcher affiliated with the University of Chicago, published a study in the *Journal of Education for Students Placed At Risk,* in 1996 that explains that for low income students whose parents move jobs often or whose housing may not be stable, the amount of times they change schools can have an exponential impact on the amount of information they miss out on. Kerbow also explained that highly mobile areas, such as urban Chicago, also face the unique challenge of high rates of student mobility affecting the school system itself. Here, schools often become trapped in a “generic” education system that is mostly “review-oriented” because the class “composition is likely to change in the next month” (Kerbow, 1996). This means that because schools can’t tell what information each of its students has already learned, schools are forced to cover a broad sphere of information on each subject in an attempt to level the playing field of its students.

Low income students also face disparities in High school programs designed to help them prepare for STEM college programs. Education researchers Weis et al. (2015)noted that the main reasons that these programs often fail is because the students don’t have the foundational STEM knowledge that their richer, white counterparts typically have to participate successfully in the harder math and sciences classes. While richer, whiter students are able to take harder classes and explore the STEM world with greater ease, disadvantaged students are often stuck in (and failing) lower-level science and math classes. These programs in low-income areas, in a misguided effort to continue student advancement within the program, often are required to make the classes easier or remove the course completely, which inhibits students from learning the necessary material to prepare and succeed in college programs. A popular criticism often cited for lower-income and minority students' lack of ability to perform is often credited to newer teachers being disproportionately placed in lower-income neighborhoods. This criticism ignores research that has shown that “low-income students have equal or nearly equal access to effective teachers” that more privileged students also have (Isenberg et al, 2021). This means that while lower-income districts may be receiving newer teachers, they are just as effective as teachers in higher-income districts. Instead, the main reasons for this lack of preparedness is due to additional educational disparities that allow more privileged students to advance at a faster pace than disadvantaged students. Typical examples of this phenomenon is that lower-income students’ don’t receive additional educational opportunities such as pre-kindergarten classes, effective tutoring, or other educational summer programs. The effects of this disparity can be felt as early as elementary school, and can have lasting impacts far past high school.

While the following sections of this paper attempt to point to some reforms that can ease the burden of education loss for disenfranchised students, it's important to note that no reform offers the complete erasure of the issues facing these students. While these reforms may give students a chance to succeed relative to our current system, it must be understood that school’s budget inequalities, inequalities to accessible technologies, updated books, and tutors, as well as less known issues such as food deserts, can not be out-reformed. The only true way the United States educational system can guarantee full equality and reach its true potential to compete with other nations is to initiate a full structural change that addresses the issues above and more.

Compiled research has found that reforming the early childhood education system allows for the burdens of the United States educational system flaws to be relatively relieved. The most important of these reforms is the expansion of Pre-kindergarten classes. Research by Welsh et al. (2010), published in the *Journal of Educational Psychology*, noted that attendance in pre-kindergarten classes increased students' ability to perform better in math and literacy classes, as well as improved students' working memory and attention control. This is especially important because improved cognitive abilities also “improved the retrieval of information from long-term memory and … focused manipulation of key information for problem solving and learning” (Welsh et al., 2010). This means that pre-kindergarten classes would give students an ability to learn how to learn and how to remember before stepping into the public education system. The inherent benefits of pre-kindergarten classes don’t end there. Pre-kindergarten classes are also associated with “growth in literacy skills” and promote “social-emotional learning” (Welsh et al., 2010). Both of which are skills that help decrease disparities between low-income and middle-income students academically. Another study found that there were “modest effects” on students (particularly boys and low-income students) who participated in pre-kindergarten classes as far as middle school (Anderson, Phillips, 2017). Since more privileged students tend to enter kindergarten with a higher literacy rate and better cognitive functions, pre-kindergarten is a necessity to fight the disparities between low-income and more privileged students before they can begin.

Restructuring the elementary school daily calendar to include more breaks is also important to improving student achievement in STEM. According to researchers (Godwin et al., 2016) published in the journal of *Learning and Instructing,* “student inattentiveness…. [is] the biggest factor in loss of instructional time.” Student inattentiveness can account for “10 to 50 percent” of instructional time loss due to off-task distractions (Godwin et al., 2016). In short, instructors are losing precious time because the system isn’t designed to accommodate younger children who don’t have the attention span of the adults who designed it. One simple method to help reduce this problem is to offer more breaks to elementary students. Students given 10 or 20 minutes breaks throughout the day were shown to have math scores that were “statistically greater than after sedentary conditions,” especially for those with “lower IQs” and girls (Howie et al., 2015). This would especially benefit students and teachers alike as attention “declines mid-day” (Godwin et al., 2016). This doesn’t just have scientific backing, but real world application as well. According to global educational researchers at organizations such as NCEE, Finland is one of the top rated countries globally for education. One reason credited for their success is their educational policy of “15 minutes break for every 45 minutes of instruction” (Walker, 2014).

Another fundamental to reforming STEM education is to train teachers on how to incorporate project-based, hands-on lessons into the curriculum. Weld et al. (2015), Researchers in Tennessee who partnered with local policymakers to improve the state's STEM education, found that free local festivals that were held for the general public and students interested in STEM, help improve student participation and excitement to learn the material in about 9 out of 10 students that participated - a significant statistic as the sample size was nearly 16,000 students. Another study, a dissertation for the University of Massachusetts written by researcher Honadrdoost (2001), found similar effects were found when sixth grade students were brought to a local high school and participated in hand-on building and experimenting. These studies prove that if the school curriculum can learn to integrate hands-on STEM activities into their everyday curriculum, active student participation and interest increases. These programs also have the added benefit of encouraging both analytical and creative thinking - learned skills that can be transferred over to other educational disciplines - and are incredibly useful in the STEM field. If this curriculum is to become the national standard, teachers will need their districts or state governors to support them by investing in effective STEM oriented training. Teachers who completed one summer training session said that interdisciplinary and project-based curriculum was an “essential….teaching strategy,” and most agreed that “more training” for teachers was essential to success in the classroom (Honadrdoost, 2001). If the United States wants to compete with other nations globally, it's necessary that teachers be able to communicate complex ideas in easy to understand ways.

The United States educational system is fundamentally flawed in ways that no simple reform can fix. Fortunately, by changing the early childhood education system specifically, policymakers can hope to reduce burdens of inequalities for disadvantaged students. Reforming the early childhood education system is the most effective way to stop education disparities before they begin. These reforms and restructures should focus around the expansion of pre-kindergarten classes, allowing for breaks for younger students in elementary school, and investing in project-based teacher training to keep students engaged in the classroom. Policymakers interested in genuine education reform should also eventually look into food desert deduction policies, textbook and technology upkeep,, as well as funding, and general curriculum reform - all of which are desperately needed. The United States education system, while lagging at the national level, can utilize these basic reforms outlines to attempt to finally bring the school system into the twenty-first century and compete with other nations.

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