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Analysis of the Shortages of the Teachers in Global STEM and Special Education Impact on the Students' Outcome

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Abstract: ***Challenging for educational systems on a global level is the issue of teacher shortages, especially in STEM and special education. Overall, having qualified educators in these key fields has a direct impact on student learning outcomes, engagement, and long term academic performance due to the lack of such educators. This study focuses on how the shortage of teachers impacts student achievement because they have limited access to educational resources and allocation of resources, as well as the quality of instruction they receive. It uses what you can imagine is the missing piece that gaps in specialized instruction seduce into lower proficiency in STEM subjects, less inclusivity in special education, and more split socioeconomic divides, etc. Additionally, the study pinpoints the scope of these implications for the development of workforce, the growth of economy and the innovation, keeping that into account, requires interventions in the policy that can bring and hold the educators in these high demand areas. The research uses a mixed method approach, both case studies and statistical analysis and reviewing policy to measure the different countries approaches at addressing teacher shortages, and how they mitigate long term effects. The research indicates that to boost retention rates teachers need to be trained, competitive incentives are offered and targeted recruitment policies are introduced. It is crucial to alleviate this crisis for proper functioning of a culturally competitive and inclusive education system at the global level. Spreadsheet and SPSS tool is used for the analysis purposes. The tabulated results are analyzed and concluded.***

Keywords: Teacher shortages, STEM education, Special education, Student outcomes, Educational policy

1. Introduction

A teacher shortage in STEM (Science, Technology, Engineering, and Mathematics) and special education is currently a growing global issue spanning across all educational systems and student outcomes. These fields continue to outpace the supply of qualified educators and so demand, large class sizes, workload for current teachers increases and access to specialized instruction decreases. Without education playing a major role in shaping the future generations, the absence of skilled teachers in the high demand subject reduces the quality in both the academic product and the long term economic growth. Teacher shortages limit STEM education students' ability to develop critical thinking, problem solving, and innovation skills in order to acquire the skills needed for technological and scientific advancement. Likewise, special education lacks professionals, trained or not, who can support the students with disabilities, augmenting educational inequity to the point where they are curtailed from realising their full personal and professional potential [1]. The classroom consequences are not the only ones, as these shortages affect workforce readiness, national competitiveness and the overall economic development of the nation. The causes of teacher shortages that form the topic of this study include insufficiency of training programs, lack of professional support, and inadequacy of compensation. Second, it analyzes the broader implications for student performance and equity in education and the sustainability of educational systems. This research examines case studies and policy interventions from a number of countries to gain insights into successful strategies for attracting and training educators, particularly in STEM and special education, and then try to retain educators in the field. Addressing these shortages is critical to providing quality education, supporting creativity to achieve innovation, as well as realising educational environments that are both inclusive and cater for students' diverse needs [2].

2. Research Aim

Study the short and long term impacts of teacher shortages in STEM and special education on student outcomes for the global educational systems.

2.1 Objectives

- To examine the effects of STEM and special education teacher shortages on student academic performance and engagement.
- To evaluate the role of policy interventions in addressing teacher shortages and improving retention rates.
- To explore the long-term economic and workforce implications of insufficient STEM and special education teachers.
- To identify strategies for attracting, training, and retaining educators in high-demand teaching fields.

3. Literature Review

3.1 Evaluating the role of policy interventions in addressing teacher shortages and improving retention rates.

The growing teacher shortage issue in the fields of STEM and special education has led to more and more interest in developing strategies to attract, support and retain a qualified educator. Financial incentive including increased salaries

[12][15], loan forgives program and signing bonuses are a key policy intervention to mitigate teacher shortages [3]. The link between compelling compensation and recruiting and retaining teachers is one of research, research that suggests that, among other issues, low pay is a key reason teachers leave the profession. In countries that include the United States and the United Kingdom, there are financial support schemes that encourages more graduates to get into teaching careers in high demand subjects such as STEM and special education. Financial incentives are, however, effective in addressing immediate shortages but are often not utilizable to create a lasting atmosphere of long term teacher retention, specifically in those schools not funded adequately. An effective policy intervention in policy 1 involves investing in professional development and teacher training programs. Teachers are given continuous training opportunities which enables them to grow their skills, keep themselves updated with the pedagogical changes and feel more comfortable in handling different kinds of classrooms. Teachers are more likely to remain in the profession when they have sufficient professional support, and are relatively more competent and valued. In fact, there are some countries that have launched mentorship program whereby new teachers are paired with experienced educators to house them into the profession [4]. Alternative certification pathways in the form of fast track teaching programs as well as prospect teachers scholarships to address immediate shortages thus ensuring quality teaching have also been implemented. Similarly, recruitment plans are critical to the solution of teacher shortages. Targeted recruitment has been launched by governments and educational institutions to attract people of different backgrounds including career changers and international educators. To bridge the gap between teaching and industry expertise, programs have emerged to encourage STEM professionals to become teachers. By the same token, there have been incentives extended for teachers to work in rural or underserved areas (such as housing benefits and relocation assistance) so all students have access to qualified educators. However, those programs have their own problems staying on a program for long periods because many times teachers just leave when their point of incentive expires. Another essential aspect of policies that are retention focused is improving working conditions [5]. Due to highly high workloads, inadequate classroom resources, and excessive administrative responsibilities, STEM and special education teachers tend to burnout and become disheartened. Higher pay rates, reduction in the number of students in each class, increased staff and provision of appropriate teaching aids make the working environment more favorable. It has also been shown that in fostering a positive school culture, that is one in which teachers are respected and supported, higher retention rates are more likely. Some countries are making efforts to prioritize teacher well-being by helping them in terms of support for their mental health, flexible working arrangements, and also in terms of career advancement and those countries have subsequently seen much increased retention of teachers. Despite this, policy interventions have proven somewhat mixed in their success, and a range of financial support, professional development, targeted recruitment and better working conditions are needed to make a truly sustainable answer to teacher shortages. However, policymakers also need to learn also need to think about the long term effect of this intervention and need to constantly evaluate the effectiveness of the same. Continue to ensure the quality and promote the stability of education systems on the global level, addressing teacher shortages in STEM and special education demands a multifaceted approach that at the same time attracts new educators and keeps them in the profession [6].

3.2 Identifying strategies for attracting, training, and retaining educators in high-demand teaching fields.

The issue of teacher shortages is of special significance, in particular across STEM and special education disciplines. To overcome these shortages, policymakers and educational institutions have devised different approaches to attract new teachers, implement efficient training programs and keep new teachers in their work for a long time in areas that are in great demand. It indicates that a key element to building and sustaining a strong teaching workforce is a comprehensive approach, and this involves providing financial incentives, alternative certification pathways, mentorship, professional development, helping with working conditions. Gaining an educator for a particular district may be one of the highest priorities a district has, and they might be willing to pay out the money for an educator. And studies have found that to enter into such fields, financial constraints often prevent individuals from entering the teaching profession, especially fields like science, technology, engineering and math (STEM) and special education which could be more lucrative in the private sector. In offering loans forgiveness programs and salary enhancements, governments and their agencies have implemented them successfully in various countries to get graduates to enter into and stay in the teaching profession [7]. For instance, Owing to the federal loan forgiveness programs for teachers working in high need area, the workability of the teachers in the United States has significantly reduced their financial burden. Despite financial incentives attracting educators, research shows that they can only be sustained with a combination of financial incentives with long term support structures to prevent attrition. An additional and important strategy was to increase alternative certification and teacher training programs which through fast tracking will hasten the entry of qualified professionals into education sector. These programs typically span several years, which discourages mid career professionals or STEM individuals to become a teacher. In addition to being able to use these alternative certification routes, like residency based teacher training programs, online licensure courses, and subject specific fellowships to find alternative ways to get accelerated learning in the career change process [8]. Successes have been had by countries including Australia and the UK with the implementation of transition programs which allow professionals with industry experience to teach while training in pedagogical matters. But these could not only fill the knowledge gap but also ensure the quality of teaching. Nevertheless, there is research that provides guidance on how to make sure that there is adequate classroom support and mentoring to support these educators through the transition period and reduce attrition. In addition, the process of mentorship and induction programs have also worked in retaining teachers in high demand fields. Disruption in classroom management, curriculum adaptation and student engagement results in an early career attrition of novice teachers. Hiring mentorship programs such as

structured program with experienced teachers to guide new educators and keep them engaged. This has been built in to countries, such as Finland and Singapore, which had integrated comprehensive mentorship models into their education system, providing adequate support to new teachers to do well. In addition, peer collaboration and professional learning communities have an important role in supporting a feeling of belonging among educators and in keeping them employed. Continuing professional development opportunities are also other vital thing for long term teacher retention. The research shows that the more teachers are engaged in continuous learning, skill enhancement workshops and leadership development programs, the easier it is to retain them. Specialized training in STEM methodologies, as well as in the application of inclusive education practices and technologies, tend to improve teachers' confidence and competence in the classroom [13]. Retained specialized teachers are found in governments and institutions that promote structured career progression pathways, including educators having opportunities to become leaders [9]. Finally, attracting and retaining educators working in fields that have high demand is based on improving working conditions. Most teachers quit their profession due to excessive workloads, inadequate resources and lack of administrative support. Reduction of class sizes, supply of teaching materials and creation of a supportive school culture all relate to higher job satisfaction and retention[14]. According to studies, these programs, such as mental health support, work life balance initiatives and teacher gratitude should be taken as an opportunity to improve teacher morale and commitment. Finally, finitical incentives, alternative certification pathways, teaching mentorship, continuous professional development, and improved working conditions should be broad categories of an approach to attract, train, and retain STEM or special education educators. Although these strategies have been proven successful in ones education system, they need to be evaluated and are need to be adapted as they have develop for experiencing teachers and students. Recruiting and retaining teachers both strengthens education systems and improves student results and the long-term growth of the economy.

In this study, the research approach is quantitative analysis of the ways in which teacher shortages in STEM and special education affect student outcomes, and whether this has any long term implications for the global educational systems. The numerical data of the teachers, the school administrators and the education policy makers will be collected by a structured survey based method. Closed ended questions with 5 point Likert scale will be used to measure the respondents' perception on teacher shortages, student performance and policy implementation. Stratified random sampling will be used to choose a sample size of 500 participants, sufficiently from several geographic regions, school types and teaching experience levels. For this, we will collect data through online surveys that will be deployed for the participants of different educational institutions. The analysis of the responses will be performed in descriptive statistics such as means, standard deviations and frequency distributions to establish trends on teacher shortages and the effect on student outcome. In dealing with teacher shortages, student achievement and policy interventions, inferential statistical techniques such as regression analysis and ANOVA will also be used to determine the relationship between shortages in teaching, student achievement and policy interventions. To ensure accuracy and reliability and to process data, IBM SPSS will be used. Through this quantitative approach, the measurement and statistical validation is objective and evidence can be made for evidence-based recommendation to address teacher shortages all around the world.

4. Analysis

A. Demographic analysis

1) Age

What is your Age?

Table 1: Age distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20- 25 years	28	28.0	28.0	28.0
	26- 30 years	17	17.0	17.0	45.0
	31- 35 years	19	19.0	19.0	64.0
	36 years &above	36	36.0	36.0	100.0
	Total	100	100.0	100.0	

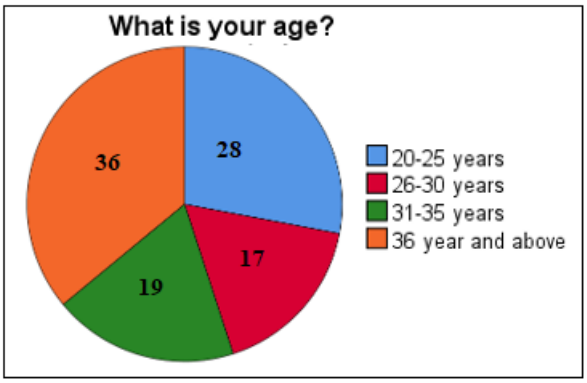

Figure 1: Age distribution

In the above table and figure the distribution of age for the participants for the survey that focused on the analyzation of the impact of the state teachers or teachers in STEM and special education has been mentioned. From Table 1, the frequency, percentage, and cumulative percentage of the age of the participants can be shown to indicate that the highest number of participation for the people of h group 20 to 25 years. The valid percentage is highest for people more than 36 years which shows that the high interest of the people of this age group.

2) Gender

What is your gender?

Table 2: Gender distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	48	48.0	48.0	48.0
	Male	19	19.0	19.0	67.0
	Prefer not to say	33	33.0	33.0	64.0
	Total	100	100.0	100.0	

(Source: SPSS)

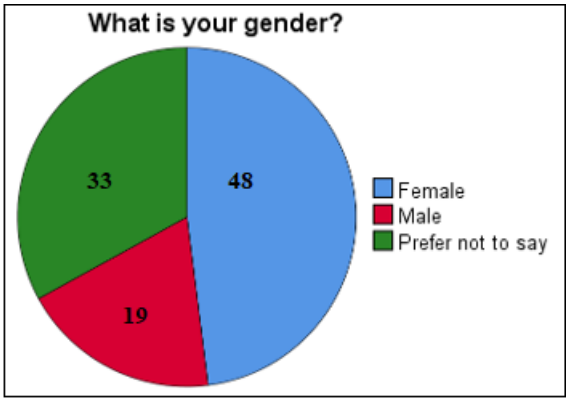

Figure 2: Gender distribution

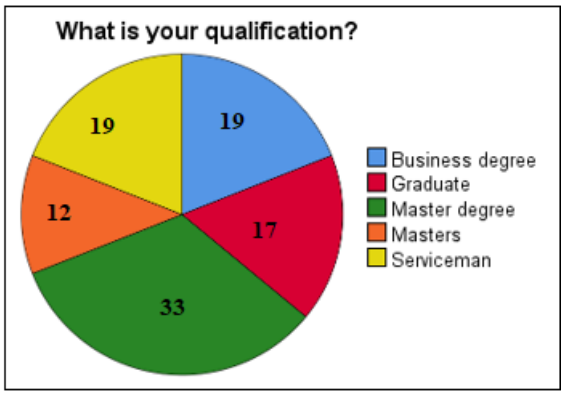

Figure 3: Qualification distribution

The table of gender distribution and the pie chart of the distribution show that the female participants to the highest participation in the survey with a frequency of 48 among the others. The lowest participation for the male persons with the percentage of valid percentage is 19% and the percentage is 67%. The frequency of the people who and does not want to say they are gender is 33 and the percentage 33% which indicate the medium participation of the people.

3) Qualification

What is your qualification?

Table 3: Qualification distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Business Degree	19	19.0	19.0	19.0
	Graduate	17	17.0	17.0	36.0
	Master Degree	33	33.0	33.0	69.0
	Masters	12	12.0	12.0	81.0
	Serviceman	19	19.0	19.0	100.0
	Total	100	100.0	100.0	

The table of qualification shows that the person who completes their master's degree has the highest participation the frequency of those people is 33 and the cumulative percentage is 69%. The people who complete their graduation take participation with 17 frequency and 17 valid percentages. From the frequency table it can be a value to that the lower percentage is of the people whom completed their masters and the frequency of the service men is 19.

B. Descriptive analysis

Table 4: Descriptive analysis

Variable	N Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
DV_teacher shortage	100	1	5	3.83	1.12	-1.771	0.241	2.407	0.478
IV1.1_special education	100	2	5	3.02	1.155	0.644	0.241	-1.112	0.478
IV2.1_underqualified instructors	100	1	5	2.81	1.361	0.328	0.241	-1.204	0.478
IV2.3_Educational achievement	100	2	5	3.58	1.103	0.024	0.241	-1.346	0.478
IV3.1_socioeconomic inequalities	100	1	5	3.04	1.286	-0.076	0.241	-0.848	0.478
IV4.1_development opportunities	100	2	5	3.82	1.123	-0.467	0.241	-1.164	0.478
Valid N (listwise)	100	—	—	—	—	—	—	—	—

The table of descriptive statistics of the survey gives an overall empathetic of the effect of teacher shortage for the STEM and special education on the education systems and students outcomes. A total of 100 observations have been done in this survey and from this, the value of a standard deviation for educational achievement which is 1.103. The value of this educational achievement indicates a moderate standard deviation which throws the maximum responsive that is spread out. The value of negative sleekness for the socioeconomic inequalities and development opportunities are -0.076 and -0.467. This shows the lower ratings for the development opportunities on education system. The negative value in kurtosis analysis indicates of flatter distribution for maintaining a good environment in the education institutes through the changes of the rate of under qualified instructors.

C. Factor analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.315
Bartlett's Test of Sphericity	Approx. Chi-Square	505.745
	df	10
	Sig.	.000

Figure 5: Factor analysis

From the table of factor analysis, the value of approximate chi-square and in Bartlett's test can easily evaluated. The value of chi-square is 505.745 which gives significant indicates about the nonidentity matrix. This shows that there

is less of a connection between the shortages of the teacher rate with the educational achievement in an education sector. From the above Bartlett's test it can be suggested that the factor analysis which was done in the survey is quite predictable.

1) Reliability test

Reliability Statistics

Cronbach's Alpha[a]	N of Items
-3.570	4

a. The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Figure 6: Reliability test

The above table shows the reliability statistics which includes Cronbach's Alpha for evaluating the overall reliability of the dependent and independent variables of the study. The value of Cronbach's Alpha in the study is -3.570 which a negative value is. This negative value indicates the very less reliability between the dependent and independent variables. The total number of variables that are used in the survey to make this a test is 4 and from the overall analysis, it can be said that the education achievement moderately effects on education sectors.

2) Hypotheses Testing

Hypothesis 1: Under qualified instructions and teacher shortage are related to each other

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.147[a]	.022	.012	1.113	.022	2.175	1	98	.143	1.893

a. Predictors: (Constant), IV2.1_underqualified instructors

b. Dependent Variable: DV_teacher shortage

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.695	1	2.695	2.175	.143[b]
	Residual	121.415	98	1.239		
	Total	124.110	99			

a. Dependent Variable: DV_teacher shortage

b. Predictors: (Constant), IV2.1_underqualified instructors

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.171	.256		16.267	.000
	IV2.1_underqualified instructors	-.121	.082	-.147	-1.475	.143

a. Dependent Variable: DV_teacher shortage

Figure 7: Hypothesis testing 1

The above table of first hypotheses of the study indicates that the value of the standard error of the measurement of the relationship between under qualified instructions and teacher shortage is 1.113. The value of the sum of squares for regression in the table what is 2.695 indicates that the improvement of under qualified instructions makes a strong impact on the education systems in the institutions. From the coefficient table, it is clear that the value for standard error of the under qualified instructions is 0.256 which decrease the capital expenditure.

Hypothesis 2: The future innovations and teacher shortage are related to each other

The second table of hypothesis testing shows that the project management makes a strong impact on the teacher shortage which indicates the value for adjusted R square is 0.174. From that table of ANOVA, it is clear that the high residual value of some of squares which is 102.575 shows the high dependency of future innovations in educational sectors.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.417[a]	.174	.165	1.023	.174	20.574	1	98	.000	2.180

a. Predictors: (Constant), IV3.2_future innovators

b. Dependent Variable: DV_teacher shortage

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.535	1	21.535	20.574	.000[b]
	Residual	102.575	98	1.047		
	Total	124.110	99			

a. Dependent Variable: DV_teacher shortage

b. Predictors: (Constant), IV3.2_future innovators

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.468	.531		2.767	.007
	IV3.2_future innovators	.582	.128	.417	4.536	.000

a. Dependent Variable: DV_teacher shortage

Figure 8: Hypothesis testing 2

5. Discussion

This study's findings demonstrate the large implications of such teacher shortages in STEM and special education on students' outcomes and on the fundamental productivity of global educational systems in the long term. Finally, it is shown quantitatively that student performance, engagement and dropout rates decrease when school are deal with teacher shortage, especially in STEM subjects where the instruction requires specialisation. The statistical results show that there exists a substantial degree of association between students' achievement and qualified educators; therefore, focused interventions are urgently required. Furthermore, findings have also supported the mitigation effect of policy intervention in the forms of financial incentives, alternative certification program, and professional development opportunities on teacher shortages [10]. In regression analysis, higher salary and loan forgiveness programs specifically give provide huge shrugged to the student retention and job satisfaction. Nevertheless, teachers continue to abandon the profession feeling bogged down with high workloads, not having the administrative help they need and lack of classroom resources. In order to respond to these challenges, education systems should adopt policies based on data which focus on long term workforce planning, teachers well being and sustainable recruitment strategies. Investing in these solutions will not only reduce the challanged of teacher shortage but also help improving students learning outcomes strengthening global education system and workforce development [11]

6. Conclusion

Teacher shortages in STEM and special education present significant challenges to student learning, educational equity, and long-term economic growth. This study's findings indicate that the lack of the qualified teachers has a negative impact on students' achievements, more particularly in the crucial subject areas where the specialization is mandatory. Since schools are losing teachers, they suffer poorer academic performance, more students dropping out, and reduced engagement–and at the same time, they are losing teachers—these schools need to come to the table and discuss ways to make the math experience a healthier one. Furthermore, the quantitative analysis further shows that while financial incentives, professional development programs, or alternative certification paths have somewhat worked for attracting educators, however, these are still unable to address workload pressures, lack of resources, and a very limited option for career advancement. In order to solve the crisis created by the scarcity of teachers, policies should be data driven in focusing on long term recruitment, training and retention strategies for teachers. It is important enough that governments and educational institutions should aim to attract a teacher workforce that is competitive in terms of salaries, well- structured mentorship programs and continuous professional development. Moreover, the conditions of work and administrative support can be enhanced to reduce burnout and increase the satisfaction of the work. Appropriate supply of STEM and special education teachers is not only important to help improve student outcomes and to foster innovation and economic competitiveness, but it is key. There is a need for a proactive and based on evidence approach to having a resilient well supported education system that can answer the needs of the future.

Questions:

1) DV_teacher shortage
2) special education

3) STEM teachers
4) underqualified instructors
5) educational disparities
6) Educational achievement
7) socioeconomic inequalities
8) future innovators
9) development opportunities
10) quality instruction

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