
**A Study on the Causal Relationship between School
Infrastructure and Student Outcome in West Delhi District**

By,

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Abstract

Education is paramount for the development of human resources across the economy. One is not alien to the fact that it is not just the teachers that impact over the learning of the student and hence their outcomes. The proper dissemination of knowledge requires an effective medium. Generally, this comes up in the form of “infrastructure”. The question at

hand being, how effective is infrastructure in serving as a medium that shall enhance student learning and hence student outcomes. The paper aims to explore in regards to the same, with the case of secondary school at hand. Student outcomes are assessed in terms of the number of students in the school who are scoring above 80 percent in 12th class Board Examination. The factors taken up for the study are. number of classrooms that are available in the school, number of books available in the library, number of washrooms available in the school and number of computers available. A Multiple Regression Analysis is run in order to study the impact of latter on former.

Keywords: Education, Schooling, School Infrastructure, Student Learning, Student Outcome

Introduction

The Indian Education Industry apart from operating about a close network of 1.4 million schools and serving as one of the key players to contribute the GDP of the country. It achieves so by improving the employment and other important factors that play a major role in the long-term development of the country by developing its human resources (Madan Sabnavis, Saurabh Bhalerao, 2018).

Thus, it becomes of paramount importance that the education industry of the country works upon the enhancement of its outcome, this mainly comes in the form of progression in the outcomes achieved by the students, this can be in the form of academic or extra curriculum. There are a variety of methods through which this can be achieved be it in terms of psychological impact, behavioral change, infrastructure etc. Infrastructure comes out to be the most important and easily influenceable factors to impact student outcomes (Schneider & M. 2003). School infrastructure can come about in various forms such as quality of teachers, type of school building, all weather roads, quality of classrooms, number of

working days, accessible library, washrooms etc. However, one may divide these various infrastructural aspects into qualitative and quantitative aspects (S Jinno & T Kosaka, 2006). Qualitative aspects may include quality of teachers, type of school building, all weather roads, quality of classrooms etc. while quantitative aspects include number of classrooms, number of books in the library, number of working days, number of faculty available per student etc. As the topic suggest the aim of the paper is to study the causal relationship between school infrastructure and student outcome, this positions quantitative aspects apt for the study (A Bobbio, L Portinale & M Minichino, 2001). Number of classrooms form a crucial factor that accounts for quantitative aspect (V Tinto, 1997). The number of classrooms is found to have a positive relation with the student progression (Plank, S., Bradshaw, & Young, H. 2009). Similarly, number of books in library (Mark Anderson, 2009), number of washrooms (F Javier Murillo, 2013) and number of computer (F Javier Murillo, 2013) are also accounted to be a factor in a variety of papers.

Incorporating the student outcomes is vital in order to measure the progress that comes out of the improvement in school infrastructure or other aspects. As discussed, this may come in the form of academic or extra curriculum. Academic performance becomes crucial when the causal relationship between school infrastructure and student outcome is to be studied (Duran-Narucki V., 2008). This may be done in the form of results achieved in tests and exams (Cellini, S.R., Ferreira, 2012). Taking the case of India into account one of the most crucial exams that takes place at a PAN India level, which happens to impact the further education of various students is 12th standard board exams. Thus, in order to assess the causal relationship between the student outcome and school infrastructure in terms of India, results of 12th standard board examination are measured to account for student outcome.

The paper aims to study how school infrastructure affect the student outcome. The question at hand is explored in West Delhi District, mainly due to the fact that the zone stands for lowest amount of dropout rate amongst all the zones of Delhi (Report of State of Public Education Delhi, 2017). It includes areas such as Anand Prabhat, Bahaduragad, Rohini, Janak Puri, Vikas Puri, Nangoli etc. A mix of government and private schools are taken up for the same. To access the effect of infrastructure on educational outcome Chapter 2 first highlights the inter-relation between infrastructure and student progression. Chapter 3 analyses the causal relationship in quantitative terms through secondary data collected. Chapter 4 aims at discussing the results obtained and also exploring the policy implication around the same. Finally, the study concludes at Chapter 5 stating that there exists a positive relationship between school infrastructure and student outcome.

Literature Review

- 1) Title: An application of “broken-windows” and related theories to the study of disorder, fear, and collective efficacy in schools.

Author: Plank, S., Bradshaw, C., & Young, H. (2009)

The research collects data from 33 Schools serving 6-8 graders in a large mid-Atlantic urban school district. The independent variables that was taken up for the study was physical disorder measures, the source of which was administrative data. The dependent variables that was taken up was measures of social disorder and collective efficacy. Path analyses reveal a direct association between physical disorder and social disorder even when prior levels of collective efficacy are controlled. Further, there is evidence that the

effects of physical disorder may be operating through increased fear and decreased collective efficacy to affect perceptions of threat/violence.

2) Title: Linking School Facility Conditions to Teacher Satisfaction and Success.

Washington, DC

Author: Schneider, M. (2003)

The research collects data from 688 schools and 1273 teachers in Chicago, IL & Washington, DC. The independent variables that was taken up for the study was school facility design & condition grades, the source of which was teacher survey. The dependent variables that was taken up was test scores and teacher health, attendance, and retention. The findings of the research suggest Poor facilities affect the health and productivity (attendance) of teachers and make retention of teachers difficult (especially for schools with a condition grade of "C" or less). On the academic side, a shift from the best facilities to the worst decreases' student test performance by ~3% (in DC this is for both math and reading, in Chicago for % of students performing at/above grade level).

3) Title: The relationship between the condition of school facilities and certain educational outcomes, particularly in rural public high schools in Texas. Author: Sheets, M. E. (2009)

The research collects data from 27 Rural Texas high schools. The independent variables that were taken up for the study were six measures of facility condition, the source of which was administrative data. The dependent variables that was taken up was Test scores, attendance & teacher experience/turnover. The findings of the research suggests the condition of school facilities has a measurable effect over and above socioeconomic conditions on student achievement and teacher experience/turnover. Most significantly, for every 10% reduction in the percent of portable facility sf/student, test scores increased

by 11 points and for every 10% increase in deferred maintenance, average test scores decreased by 0.61 points.

- 4) Title: The relationship of school facilities conditions to selected student academic outcomes: A study of South Carolina public schools.

Author: Stevenson, K. R. (2001)

The research collects data from participants of 626 South Carolina schools. The independent variables that were taken up for the study were facility condition score & condition of individual systems, the source of which was principal assessments. The dependent variables that was taken up was test score; Range of student, teacher, parent and community variables. The findings of the research suggest there is a significant relationship between building condition and test scores. Additionally, at least 75% of principals indicated that the adequacy of the school facility impacted teacher attitudes, teacher recruitment and retention, student behaviour, and parent and community attitudes and support.

- 5) Title: Relationship among School Infrastructure Facilities, Learning Environment and Student Outcomes

Author: Bijaya Nepal

A study was conducted from February to July and 2014, for which a structured questionnaire was floated in order to collect primary data to measure school's management, utilization and policies. The study was restricted to the districts of Sindhupalchok, Kavre, Makwanpur, Kathmandu and Chitwa and the size of the respondents was 3125, of which a sample of 40 schools was selected, which made a 320 of total respondents in the sample size. A multi regression analysis was run for this sample. The analysis provided the following factors imperative for student education,

good air quality, good light, a small, comfortable, safe environment, building age and condition, quality of maintenance, temperature, and colour, could affect student health, safety as well as a sense of self and psychological state.

Material and Methods

The data for this paper comes from a secondary data collection of high schools in West Delhi district conducted between March 5 and March 1, 2019. The database contains names, location, infrastructure details and student outcomes for more than 70% of public school teachers in West Delhi. To be eligible each school had to have a batch appearing for 12th standard board examination for the year 2017-18. Using secondary methods data was collected for 54 public and private schools in West Delhi.

Data were analysed with the Microsoft Excel (2016 Version). Results are expressed as mean, standard deviation (SD) or 95% confidence interval (95% CI). The Cronbach Alpha Test was used to determine the reliability of the data. Quantitative data with a normal distribution were analysed with parametric tests. Multicollinearity test and Cronbach Alpha test was conducted to check for multicollinearity and reliability in the data. The reliability of the coefficient obtained was checked against significant p-value.

Relation between Student Infrastructure and Student Outcome

As per the previous discussion, school infrastructure plays an important role in student outcome and progression, it becomes vital to understand the various aspects of school infrastructure, their relevance and effectiveness in terms of student progression. School infrastructure if not the primary but is definitely principal to the improvement and

enhancement in the outcomes of the student (Bijaya Nepal, 2014). Many papers attempt to divide the infrastructural aspects into a number of sub categories on various basis such as non-modernized, modernized and new on the basis of school building structure along with a number of structural and cosmic factors (Fisher and Kenn, 2001). However, on a general basis one can divide the infrastructural aspects into qualitative and quantitative factors. For the purpose of studying the causal relationship between student outcomes and the school infrastructures, the research focuses on quantitative aspects. These include number of books, number of faculty available, number of classrooms, number of working days etc.

Number of classrooms available forms to be an important aspect in school infrastructure, it not only ensures a greater number of students in school but also accounts for comfortable learning (Ziporah Magoma & Mokaya, 2013). It ensures hassle free teaching and thus is considered to be an effective tool in bringing out affluent results (Paul Ayolo, 2015). Ensuring of greater number of classrooms helps in achieving better test results as most of the instructions are passed on to the students in the classrooms (Glen L Earthman, 1998). Therefore, number of classrooms is a crucial factor that determines the student progression and is identified as a key parameter in the study.

Similarly, another crucial parameter is the number of books in school library. Books, academic or non-academic helps the student in the learning process in various ways, it helps building their vocabulary, grasping capacity, reading skills and hence is crucial to the education of a student (RE Boyatzis, SS Cowen & DA Kolb, 1995). It is an important tool as far as input-output measure is considered (M Kyrillidou, 2002). It is even stressed that school library is key to achieving better student progression in third world countries (B Fuller, 1987).

Hygiene also impacts the education of students in an indirect fashion. Better the hygiene, better is the physical and mental health of the students hence better is the learning process. In the spirit of which, number of washrooms also becomes important to the infrastructural aspect for the study. The students should be sharing washrooms self-contained in nature and the number of should be such that only a limited number of students should be sharing a washroom at a particular point (SR Rodger & AW Jhonson, 2005). It is also important that every floor of the school building should have a different sex-specific washroom for the use (C White, R Kolble, R Carlson & N Lipson, 2003).

E-learning has become the modern imperative as far as the learning process of the students are concerned. It provides the students a world of knowledge outside the books, thus extending their exposure and relevance in relation to their subject matter. Therefore, making number of computers a key factor for the study. Computer by extending a sea of information helps in the enhancement of student writing (A Goldberg, M Russell & A Cook, 2003). Students are also noticed to have developed a positive attitude to computer-based learning and courses (Kulik, J. A., Bangert, R. L., & Williams, 1983).

As for the determining the dependent variable for student outcome, literature suggests that 12th class national standardized exams serve as a reliable parameter. As, in order to measure the effectiveness of learning and education, academic performances are the most suitable parameter. Be it a change in the behavioral methods or the physical infrastructure the enhancement in students is reflected by their test results (CP Bradshaw & MM Mitchell, 2010). Moreover, high stake tests such as competitive exams or national standardized tests serve as a more effective parameter in order to assess the student outcomes as students themselves realize the gravity of performing in such tests (M Carnoy & S Loeb, 2002). Taking this into India's perspective, 12th standard board results are one of the highest stake exams that is conducted at PAN India level and thus is used to measure student performances.

Therefore, the model thus developed for the study is as under-

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \dots + \mu_i$$

where, Y = Number of students who scored above 80 percent in board exam

X₁ = Number of Classrooms

X₂ = Number of books in library

X₃ = Number of Washrooms

X_4 = Number of Computers

Chapter 3 illustrates the analysis conducted on the secondary data collected and provides with results that mathematically proves the importance of the school infrastructure in student outcomes in the Indian context. It explains the demographics of the data collected, checks for any multi-collinearity in the dataset, ensures the reliability of the data and then proceeds towards conducting a Multiple Regression Analysis taking the number of classrooms, books in the library, washrooms and computers as the independent variable and 12th standard board results as the dependent variable.

Data Analysis

As explained before, various variables that are imperative in order to study the causal relationship between school infrastructure and student outcome. Chapter 3 is based on analytical interpretation of secondary data collected of the same variables using convenience sampling. The sample size for the purpose of the study is 54 schools collected from West Delhi district. A mix of government, private and public schools were taken in the sample. To analyze the data, different statistical tools were used like mean, standard deviation, simple correlation and multiple linear regression. Cronbach's alpha is used to check the reliability and internal consistency of the data collected for the purpose of the research. Microsoft Excel was used to conduct the analysis.

Hypotheses

H1: There is no significant relationship between number of classrooms and student outcome.

H2: There is no significant relationship between number of books in library and student outcome.

H3: There is no significant relationship between number of washrooms and student outcomes.

H4: There is no significant relationship between number of computers and student outcomes.

Results and Discussion

Demographics of the Respondents

Table 1: Demographics of the Observations

DEMOGRAPHICS		FREQUENCY	PERCENTAGE
Number of Schools	Government	27	50.94
	Private	26	49.0566
Number of Classrooms	Government	485	39.88
	Private	731	60.115
Number of Books in Library	Government	161703	34.81
	Private	302757	65.184
Number of Washrooms	Government	86	37.229
	Private	145	62.7705

Number of Computers	Government	263	19.155
	Private	1110	80.844
Number of Students scoring above 80%	Government	285	24.912
	Private	859	75.087

Source: Compiled and Constructed

As it is clear from the table above, an observation of 54 schools are taken up for the analysis purpose, wherein 50.94 percent of the schools are government while 49.0566 percent of the schools are private. In our sample population the government schools account for the 39.88 percent of the total number of classrooms while the private schools account for the 60.115 percent of the total number of classrooms. Similarly, government schools have 34.81 percent share while the private schools have a 65.184 percent share in the total number of books in the library. While the government schools account for 37.229 percent of the of the total number of washrooms, private schools are accountable for 62.7705 percent of the total washrooms. 19.155 percent of the total computers are available with the government schools whereas private schools have 80.844 percent of the total number of computers. In terms of student outcome, 24.912 percent of students in the sample who scored above 80 percent in board exams belong to government schools while 75.087 percent belong to private schools.

Descriptive Analysis and Reliability Test

This test is performed mainly to check the reliability and internal consistency of the sample data collected for the purpose of the study. The statistical tool used to conduct reliability test is Cronbach’s Alpha. Any value above 0.5 is acceptable.

So, the Cronbach’s alpha values for different variables under study were computed to be 0.894. Thus the Cronbach’s Alpha value is above 0.5 which shows a good internal consistency in the dataset having found data to be reliable. Multiple Regression Analysis has been conducted with the regression equation-

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \dots + \mu_i$$

Multicollinearity Analysis

One of the key assumptions of multiple linear regression analysis is that there should be no multicollinearity in the model. Multicollinearity is a situation of high intercorrelation among the independent variables. To check the multicollinearity, simple correlations analysis is conducted among the independent variables. Any value more than 0.7 signifies multicollinearity.

Table 3: Multi-Collinearity Test

	Number of students who scored above 80%	Number of Classrooms	Number of Books in Library	Number of Washrooms	Number of Computers Available
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Number of students who scored above 80%	1				
Number of Classrooms	0.346049768	1			
Number of Books in Library	0.492473170	0.446835084	1		
Number of Washrooms	0.560963319	0.560378786	0.484631274	1	
Number of Computers Available	0.757678743	0.404024826	0.562393433	0.539670201	1

Source: Compiled and Constructed

As it can be seen in Table 3 the value of Number of classrooms, Number of Books in Library, Number of Washrooms and Number of Computers Available are below 0.7, the dataset is non-multicollinear.

Multiple Regression Analysis



Multiple regression analysis is a statistical tool used to determine the relationship between the student outcome and its determinants (number of classrooms, number of books in library, number of washrooms and number of computers available). The results are listed as under: -

Table 4: Summary Output of Multiple Regression Analysis

SUMMARY OUTPUT								
<i>Regression Statistics</i>								
Multiple R	0.891912							
R Square	0.795507							
Adjusted R Square	0.778465							
Standard Error	0.415179							
Observations	53							
ANOVA								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	4	32.18675	8.046687	46.68158	5.75E-16			
Residual	48	8.273947	0.172374					
Total	52	40.46069						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	-0.64149	0.197103	-3.25458	0.002084	-1.03779	-0.24519	-1.03779	-0.24519
X Variable 1	0.351955	0.11383	3.091941	0.003308	0.123085	0.580826	0.123085	0.580826
X Variable 2	0.238439	0.133444	1.786814	0.080283	-0.02987	0.506745	-0.02987	0.506745
X Variable 3	0.268853	0.092985	2.891355	0.005747	0.081894	0.455812	0.081894	0.455812

X Variable 4	0.216553	0.105361	2.055345	0.045308	0.004711	0.428396	0.004711	0.428396
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Source: Compiled and Constructed

From the table, the p value of the number of classrooms ($p= 0.002084276271$) is less than the significance level 5 percent. Thus, we reject the null hypothesis H_1 and conclude that there exists a positive relationship between the number of classrooms and student outcome. Similarly, p value of the number of books in library ($p= 0.08028348661$), number of washrooms ($p= 0.005746975914$) and number of computers available ($p= 0.04530837008$) is less than the alpha value of 0.05 (except for number of washrooms which is significant at 10 percent level of significance). Thus, we can *reject null hypothesis H_1, H_2, H_3 & H_4* and conclude that all the *four variables are positively related* to green purchase behavior.

Therefore, the *Multiple Regression Equation* formed is-

Number of Students scoring above 80 percent in Board Exams=

$-0.6414879317 + 0.3519552978(\text{Number of classrooms}) + 0.2384390284(\text{Number of Books in Library}) + 0.2688529723 (\text{Number of Washrooms}) + 0.2165533792(\text{Number of Computers Available})$

The analysis suggests that for an unit change in the number of classrooms there will be 0.3519552978 unit change in Number of Students scoring above 80 percent in Board Exams. Similarly, a 1 unit change in Number of Books in Library, Number of Washrooms and Number of Computers Available will bring an 0.2384390284, 0.2688529723 and 0.2165533792 unit increase in Number of Students scoring above 80 percent in Board Exams.

Chapter 4 shall discuss the implications of these results in details for each factor that is taken up for the analysis. It further suggests “policies” that can be implemented in order to ensure further student progression. These policies fall in line with the results obtained in Chapter 3.

Discussion and Implications

The detailed results of the above analysis conducted suggests towards the implications and consequent policies that maybe adopted or have been adopted. Following is the discussion with respect to each factor and consequent policies for each factor separately-

Factor One: Number of Classrooms

The importance of number of classrooms in better learning has been stressed time and again. Overcrowding in classrooms and consequent lack of failure on the part of teachers to facilitate better learning is a common problem (Parveen Khan & Mohommad Iqbal, 2012). Looking at the sample dataset one may derive that the availability of classrooms in government schools are far greater than that in private schools. Lack of funds is one of the major reasons behind such a trend. The role of classrooms in student outcome is highlighted by the results of analysis of the sample data taken into consideration.

Apart from increasing the number of classrooms, schools should also focus on the better maintenance and aesthetics of the existing ones wherein lighting, temperature and color should be taken care of (Bijaya Nepal, 2014). Better looking classrooms are known to create a psychological impact in the minds of the students that aid them in the learning process (Peter Barrett, Alberto Treves, Tigran Shmis, Diego Ambasz, & Maria Ustinova,

2018). Moreover, various group mechanics may also be employed to avoid overcrowding in classrooms.

Factor Two: Number of Books in Library

Apart from visual aids and other electronic gadgets, one of the conventional methods of learning are books. Availability of books in the library signifies the greater disposal of knowledge at hand for the students. Books help in development of the reading habits, improving knowledge, develop patience and making students more articulate (TM McDevitt & JE Ormrod, 2010). Also, the development of vocabulary through books via reciprocal learning helps in enhancing student outcome (MR Ahmadi, HN Ismail & MKK Abdullah, 2012). Moreover, decent collection of academic books or academic journals helps in the availability of content that can be used for formulating better answers in exams (CT Lewis & T Hedegaard, 1993). Our dataset suggests a larger collection of books in private schools rather than in government schools.

However, simply the availability of books in library is alone not sufficient for the better acquiring of knowledge as not all students are not necessarily motivated to go library and read books (LB Gambrell, 1996). There are less chances of all the students being equally motivated to borrow books from library and study. Moreover, with the existence of visual aids and other electronic gadgets at hand, students relying on books to study is less likely, as watching a particular visual comes much easy than reading through 200 crore words (JE Renegar & US Paten, 2000). This explains the reason behind the variable being significant at 10 percent level of significance.

Factor Three: Number of Washrooms

Sanitation is also one of the major factors to look after in order to ensure better student outcomes. Clean sanitation ensures the wellbeing of the students which in turn helps them to concentrate on studies that enhances the student outcomes. Maintenance of hygiene helps in the physical health of the student.

Lack of enough washrooms in the government schools imposes a serious problem at hand. This results in impacting the hygiene of the students and thus the student outcome (FC Brown, WC Buboltz Jr & B Soper, 2002). Installing proper toilets with functioning urinals, sinks, running water and other necessary toilet equipment is utmost necessary for the authority.

Apart from ensuring the toilets are installed proper care has also to be given to the fact that they are maintained properly and are in usable conditions. Employing janitors and using cleaning equipment for the same is advisable.

Factor Four: Number of Computers

Of all the electronic gadgets that come to be useful in the education and learning process, computers are the primary. Availability of computers in schools make the students computer ready at their own home as well. It is important for the students to learn the basics of the device in schools, before they go on to use them educational purposes in their later stages. Moreover, computers are also helpful for the students to explore beyond the prescribed syllabus and educating themselves for knowledge sake rather than just scoring marks (P Aseno, 2012). It helps in the development of inquisitive character in the students that proves

to be much useful as they go on to become professionals. It serves as one of the most effective agents in the purpose of education, i.e., constructivism (M Ben & Ari, 2001).

After explaining the causal relationship between the factors, detailing on the analysis conducted and an illustrative discussion on the results and its implication the paper is concluded in Chapter 5.

Conclusion

Education is paramount for the development of human resources across the economy. Education can be defined as the process of acquiring knowledge, skill, habits, believes etc. Education helps us in a great extent in the process of Human Capital Formation in the country. The proper dissemination of knowledge requires an effective medium. Generally, this comes up in the form of “infrastructure” (D Rich, 1993). Infrastructure, maybe used as broad umbrella term to cover in all aspects. The paper aims to assess this causal relationship between infrastructure and education.

In order to do so secondary data is collected of following variables, number of classrooms that are available in the school, number of books available in the library, number of washrooms available in the school and number of computers available. These are taken to be independent variables against the number of students who scored above 80 percent in board examination as a dependent variable which is used to measure the student outcome.

The analysis of the sample suggests that all the independent variables have a positive relation with the dependent variable. Thus, leading us to believe that the infrastructure plays a definite role in affecting the student outcome. Also, the R square suggests that apart from

these 4 factors there are other infrastructural aspects as well that impact the student outcomes.

Number of Classrooms and creating one which the student experience as community and their maintenance is vital for both students and teachers for the better understanding and dissemination of knowledge (D Solomon, M Watson & V Battistich, 1996). Number of Books in Library signify more knowledge in hand for the use of the students (A Tiwari & C Tang, 2003), however it does no guarantee the passing on of the knowledge to students and thus explains it lower level of significance. Moreover, number of clean washrooms and their maintenance serve as medium to better hygiene conditions which meets the basic student expectations (W Lehmann, 2009). Last but not the least, number of computers and their use seems to be the next best solution to books in the era of modernization and also helps in making the industry ready by incorporating a variety of practical skills (J Repman, 1993), thus aiding Human Capital Formation.

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