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The provision of electricity and internet access to DepEd schools and its impact on school performance[1]

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Abstract

Among the interventions that the Department of Education (DepEd) intends to implement with respect to disadvantaged or the so-called "last mile" schools (LMS) are the installation of solar panels to energize schools with no electricity, the provision of internet connection to schools with no internet access, and computerization packages. Implied in these interventions is the assumption that national divides in access to electricity and to information and communication technologies (ICTs) have implications for learning and school performance.

In order to validate the assumption that electrification and internet access improve school performance, an exploratory data analysis was performed based on National Achievement Test (NAT) results and data on electrical and internet connectivity using the Python programming language. The impact of electrification of schools on NAT performance is evident, but the analysis does not support the impact of internet access. The findings have implications for prioritization in the provision of needed support for last mile schools, considering the limited resources for education.

Background

Studies on the role of energy in development argue that access to modern energy sources—such as electricity—help stimulate both economic and human development, including educational outcomes (Matinga and Annegarn 2013). For one, electricity in schools provides students with light and allows the possibility of modern tools for teaching (Sovacool and Ryan 2016). This was observed with regard to qualitative impact of corporate social responsibility (CSR) activities that provided solar electricity to off-grid elementary and secondary schools in the Philippines (Alampay, Berse, and Cabotaje 2016). Yet there are also prioritization concerns with regard to what parts of the school to electrify, and whether there are other better things that the money for electrification projects should be spent on instead (Leitch, Scott, and Adams 1997), especially if concrete improvement in learning outcomes are not evident.

Efforts to electrify schools have lagged despite progress in electrification throughout the world to connect people to electricity networks (Sovacool and Ryan 2016). It is for this reason that the DepEd recently issued DepEd Memorandum No. 59, s. 2019, titled "Prioritizing the Development of the Last Mile

[1] This policy brief is an output from the Machine Learning Workshop organized by the Program on Data Science for Public Policy of the UP Center for Integrative and Development Studies (UP CIDS) held from July 31 to August 2, 2019.

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Schools in 2020–2021: Reaching Out and Closing the Gap." The absence of electricity was among the indicators for identifying a school as an LMS. In line with this, the DepEd intends to implement programs and projects aimed at addressing the needs of LMS. This includes installation of solar panels to energize unenergized schools, provision of DepEd Computerization Program packages, and connection of schools to the DepEd Network and the internet. Implied in this memorandum is that gaps in access to infrastructure, such as electricity and the internet, have implications to improved learning.

Evidence shows that access to electricity can impact education in various ways. For one, school electrification extends teaching and studying hours either in the morning and/or in the evening, provides access to better learning tools such as computers and televisions, helps in the recruitment and retention of better staff through trainings and access to facilities, leads to the improvement of school performance causing less truancy and higher enrollment and completion rates, and enhances other social and economic developments, such as health and sanitation (UNDESA 2014). Children with access to electricity tend to attain higher educational levels because better-quality schools include the provision of electricity-dependent equipment, and because there is more study time allocation at home and in school (IEG 2008). A study in Peru found that increased study time of children also reduces the possibility of repeating school, thus reducing resources lost by families and the government from repeaters (Aguirre 2017). In Brazil, rural school electrification also reduced dropout rates (Mejdalani et al. 2018).

Providing electricity in schools has direct and indirect benefits. Direct benefits include improvements in lighting and access to any electricity-dependent appliances or equipment. In schools powered by solar energy in the Philippines, students report using laptops, projectors, and downloaded music, which are incorporated in their lessons (Alampay, Berse, and Cabotaje 2016). Aside from better teaching equipment and facilities, electrified schools also attract more teachers than those without electricity, which positively affects the quality of teaching, as well as the level of education among electrified schools, which is the case in the Philippines (IEG 2008).

Nonetheless, while there is growing literature about the impact of rural electrification (Khander et al. 2009), knowledge about their impact have only marginally improved since the 1980s, because impact on development, including on education, has remained largely undocumented (Bernard 2010). Some designs have focused on cross-sectional studies comparing those with electricity versus those without, with very little panel surveys tracking the same sample over time (Khander et al. 2009). Others have also recommended the need for complementary services to rural electrification projects, since frequent projects tend to confine themselves to hardware financing and civil work without undertaking complementary activities to the service (Peters, Harsdorff, and Ziegler 2009).

Evidence of the impact of ICTs and the internet, on the other hand, has not been as convincing. The supposed promise that ICTs can bring better learning in primary and secondary schools is yet to be realized (Gamage and Tanwar 2018).

Methodology

This evaluation comparing electrified and unelectrified schools in terms of performance in the NAT is a contribution to this underdocumented area of development research. It tests the assumption that electrification of DepEd schools improves learning environment and leads to improved student performance in the NAT. It is based on data provided by DepEd, comparing electrified schools with non-electrified schools, and also on panel data looking at a few select schools that were known to be electrified by One Meralco Foundation (see Alampay, Berse, and Cabotaje 2016). Comparison of NAT scores was also done before and after electrification.

Data description

Data on internet, electric connectivity, location coordinates, enrollment, and teacher item of schools were provided by DepEd's Information and Communication Technology Services (ICTS). DepEd ICTS provided 2015 data for 38,418 elementary schools and 7,957 secondary schools. Data on NAT was provided by DepEd's Bureau of Educational Assessment–Education Research Division (BEA–ERD). DepEd BEA-ERD provided 10% stratified sampling of public schools nationwide of the 2011–2015 NAT takers. For this particular study, school year 2014–2015 was considered because it shows internet, electricity, and NAT data. The sample is composed of 3,377 elementary schools and 736 secondary schools. Features that have no significance for the study were removed. **TABLE 1** below lists the different attributes and their data types.

TABLE 1 Field description/data dictionary

Attribute	Field description	Data type
Reg	Region: Administrative divisions that serve primarily to organize provinces	Categorical (1 to 16)
Overall	Overall National Achievement Test (NAT) scores: The average score of the school in various subjects	Numeric (0 to 100)
Internet	Internet presence in a school	Binary (0=without internet; 1=with internet)
Energized	Presence of electric supply in a school	Binary (0=without electricity; 1=with electricity)

Computational environment

All analyses reported in this study were conducted using Python, "a widely-used, interpreted, object-oriented, and high-level programming language with dynamic semantics, used for general-purpose programming" (Python Institute n.d.). Its core libraries, combined with its strength as a general purpose programming language, makes it ideal for advanced analytics. The specific Python libraries used in this study were NumPy and Pandas for scientific computing and data analysis, and Matplotlib and Seaborn for data plotting and visualization.

Data analyses were done in Jupyter Notebook, "an open-source web application that allows [users] to create and share documents that contain live code, equations, visualizations and narrative text" (Project Jupyter n.d.). It can be used for "data cleaning and transformation, numerical simulation, statistical modeling, data visualization, machine learning, and much more" (ibid.).

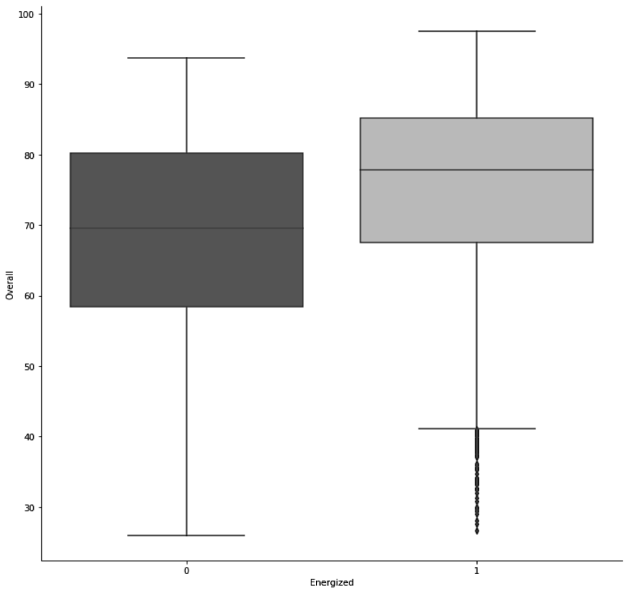
Although the study initially intended to employ machine learning algorithms, an exploratory data analysis was enough to provide the insights needed for the objectives of the study.

Findings

School electrification and NAT performance

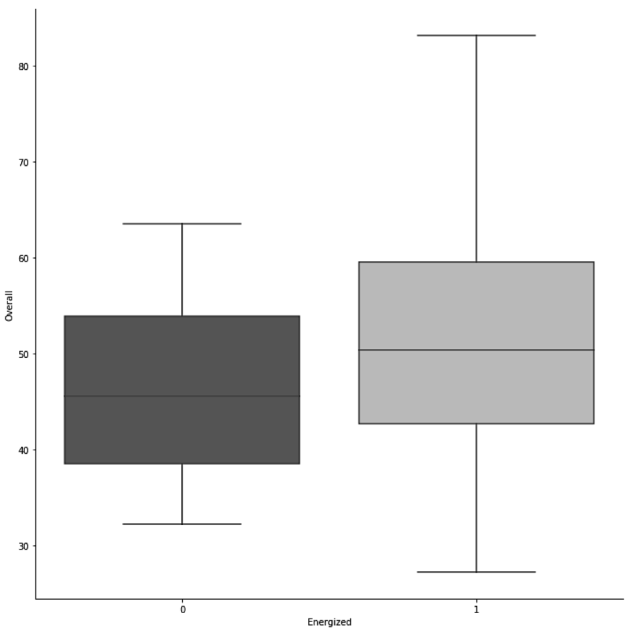
As of 2015, around 10% of sampled elementary schools and 3% of sampled secondary schools are "unenergized" or did not have electricity. On the average, elementary schools with access to electricity

FIGURE 1 Overall NAT performance of unenergized and energized elementary schools



Source: DepEd 2015

FIGURE 2 Overall NAT performance of unenergized and energized elementary schools



Source: DepEd 2015

(energized) performed 12% better than those that did not have electricity. For secondary schools, energized schools performed 10% better than unenergized ones.

When scores were disaggregated per subject, energized schools, both primary and secondary, also performed better across all subjects (see **TABLES 2** and **3** below).

TABLE 2 Median scores of unenergized and energized elementary schools on NAT subjects

Subject	Unenergized	Energized
Filipino	68.125	73.750
Araling Panlipunan	71.071	78.366
Mathematics	74.329	82.264
Science	65.278	75.303
English	71.944	80.926

Source: DepEd 2015

TABLE 3 Median scores of unenergized and energized secondary schools on NAT subjects

Subject	Unenergized	Energized
Filipino	54.574	59.644
Araling Panlipunan	43.256	49.153
Mathematics	40.516	51.770
Science	36.558	45.616
English	43.210	45.616
Critical Thinking	39.375	43.182

Source: DepEd 2015

Among the NAT subjects, Science has a larger median improvement when the school is energized. Some hypotheses can be made for further study. This may mean that being energized means more laboratory experiments that can be performed by students, thereby increasing their learning in Science. Another reason would be that energized schools also gain access to other supplementary multimedia materials, as experienced in documented cases of solar electrification in schools that were supported by the project of the One Meralco Foundation (Alampay, Berse, and Cabotaje 2016).

Internet connectivity and NAT performance

TABLES 4 and **5** below show the median score and the percent difference (Internet vs. no Internet) for the various NAT subjects of both elementary and secondary schools.

TABLE 4 Median scores of elementary schools with and without internet access on NAT subjects

Subject	With internet	Without internet	Difference
Filipino	73.333	73.250	0.114
Araling Panlipunan	78.047	77.500	0.706
Mathematics	81.443	81.848	–0.494
Science	75.381	74.183	1.616
English	80.432	80.385	0.059

Source: DepEd 2015

TABLE 5 Median scores of secondary schools with and without internet access on NAT subjects

Subject	With internet	Without internet	Difference
Filipino	59.715	58.856	1.456
Araling Panlipunan	49.277	47.743	3.211
Mathematics	51.839	50.600	2.449
Science	46.748	48.164	–2.940
English	45.355	46.278	–1.994
Critical Thinking	42.984	44.356	–3.092

Source: DepEd 2015

Unlike the results of energized schools, no significant effect on performance was observed on internet connectivity. In some cases, the performance was even lower (e.g., Science, English, and Critical Thinking in secondary schools). However, data on internet connectivity in schools do not incude information based on service quality indicators (e.g., speed, bandwidth, reliability), which may vary from region to region.

Implications

Findings from this assessment on the impact of electrification and internet access are mixed, but consistent with the literature. Electrified primary and secondary schools perform better than non-electrified schools, although more evidence is needed in terms of time-series data over the years. In addition, internet access does not seem to have an effect on NAT performance. While this is also consistent with literature, it may also be affected by the differences in the quality of access across the country. Some also suggest that teachers' adoption and use of ICTs in the classroom are factors that have to be considered in looking at the impact of ICTs in learning outcomes (Gamage and Tanwar 2018).

An exploratory data analysis was done to show the correlation of the variables with NAT school performance. Although this study did not employ educational data mining (EDM) and machine learning (ML) algorithms, EDM and ML techniques may be used to further identify the features or attributes that greatly contribute to the NAT overall performance of schools.[4] It would also help for the Department of Education to make it a policy to make their education data on schools and school performance more open and accessible. This will allow researchers to increase the number of schools that will be used in EDM and ML models, and make results more robust and be more useful for policymakers.

Further research may be done on how internet connectivity is utilized in schools, particularly in how teachers adopt the technology. Similar to the experience with electricity, development impact may not be apparent nor materialize because of absence in complementary services, policies, traditions, and power relations, among others (Matinga and Annegarn 2013). For instance, future research relating internet connectivity to class school performance should consider whether the use of the internet is actually necessary for their subjects, for which classes internet use is allowed or not allowed, and how much time the class spends on the internet for these subjects. ■

[4] Educational data mining (EDM) "is [...] concerned with developing methods for exploring the unique and increasingly large-scale data that come from educational settings and using those methods to better understand students, and the settings which they learn in" (International Educational Data Mining Society n.d.). Machine learning (ML), on the other hand, "refers to the automated detection of meaning patterns in data" (Shalev-Shwartz and Ben-David 2014, xv). EDM and ML algorithms are already being utilized in researches to predict performance of students and schools using various attributes or predictors.

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