Article

Provision of Electricity and Internet Access in DepEd Schools: Implications on School Performance and Digital Inclusivity in the New Normal

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Abstract

The COVID-19 pandemic has highlighted the importance and urgency of supporting infrastructure that would make access to education more resilient. This includes access to electricity and the internet to allow for remote learning platforms. Access often varies and may be difficult because of geographic and economic differences. This leads to disadvantages manifested in digital divides that may contribute to learning poverty. The Department of Education (DepEd) has implemented numerous interventions with respect to disadvantaged or so-called "Last Mile" schools (LMS), including energizing schools without electricity, connecting them to the internet, and providing computerization packages. Implied in this policy is the assumption that national divides in electricity and Internet access have implications on learning and better school performance. To validate the assumption that electricity and Internet access improves school performance, the authors performed exploratory data analysis (EDA) on National

Achievement Tests (NAT), a standardized examination in the Philippines. In addition, electrical and internet connectivity data from DepEd was analyzed using Python programming language. This was then complemented by data from a panel of schools where NAT scores were compared before and after electrification. Evidence on the impact of energizing schools in NAT performance was supported in the EDA, but it was not evident with respect to internet access. The findings highlight the importance of prioritizing the provision of necessary support for Last Mile Schools (LMS in light of limited education resources and the future of education in the post-COVID-19 world. However, the findings also reiterate the need to expand assessments beyond questions of internet access or digital divides, and consider other aspects of digital inclusivity as a function of developing digital literacies.

Keywords

Last Mile Schools, Digital Inclusion, School Electrification

School Infrastructure and Learning Outcomes

There is evidence around the world, such as in countries in Latin America, that prove the improving of school infrastructure leads to better learning outcomes (Murillo and Roman 2011). The availability of basic school infrastructure (e.g., electricity, water, sewage, classrooms, desks, and chairs) and facilities (e.g., laboratories, libraries, and blackboards) has been associated with better student learning achievement (Al-Samarrai 2016; Murillo and Roman 2011). Studies on energy for development also argue that access to modern energy sources, such as electricity, helps stimulate both economic and human development, including educational outcomes (Matinga and Annegard 2013). For instance, electricity in schools not only provides students with light but also allows the possibility of modern tools for teaching (Sovacool and Ryan 2016). This was observed with regard to the qualitative impact of corporate social responsibility (CSR) activities that provided solar electricity to off-grid elementary and secondary schools in the Philippines (Cabotaje, Alampay, and Berse 2021). Cabotaje, Alampay, and Berse (2021) found that electrification allowed the introduction of information and communication technologies (ICTs) (e.g., laptops and audiovisual technologies), which led to innovative use and new capabilities (e.g., making PowerPoint slides and listening to digital recordings).

Evidence shows that electricity access can impact education in various ways. For instance, school electrification extends teaching and studying hours either in the morning and/or in the evening; without it, classes will be dependent on available natural light and on the seasons. Direct benefits include improvements in lighting and access to electricity-dependent appliances or equipment, such as computers and televisions sets. In schools powered by solar energy in the Philippines, for instance, students report using laptops, projectors, and downloaded music, which are incorporated in their lessons (Cabotaje et al. 2021). Electrification also helps with the recruitment and retention of better staff through training and access to facilities. Therefore, it leads to the improvement of school performance, results in fewer incidents of truancy and higher enrollment and completion rates, as well as enhances other social and economic developments such as health and sanitation (United Nations Department of Economic and Social Affairs [UN DESA] 2014). Children with electricity access tend to attain higher educational levels because better-quality schools include the provision of electricity-dependent equipment and the allocation of more study time at home and in school (World Bank Independent Evaluation Group 2008). A study in Peru found that children's increased study time also reduces the possibility of repeating a grade level, thus reducing resources lost by families and the government from repeaters (Aguirre 2014). In Brazil, rural school electrification also reduced dropout rates (Mejdalani et al. 2018).

Efforts to electrify schools have lagged, despite the progress of electrification throughout the world (Sovacool and Ryan 2016). Although there is growing literature about the impact of rural electrification (Khander et al. 2009), knowledge about its impact has only marginally improved since the 1980s, because impact on development, including in education, has remained largely undocumented (Bernard 2010). Some designs have focused on cross-sectional studies comparing those with electricity and those without it. Very little panel surveys tracking the same sample over time were conducted (Khander et al. 2009). Others have also recommended the need for complementary services to rural electrification projects, particularly since frequent projects tend to confine themselves to hardware financing and civil work without undertaking complementary activities to the service (Peters et al. 2009). Internet access and the remote learning that it enables are arguably such complementary services, with electricity identified as a key factor to remote learning (Jeon et al. 2021). One example is the use of information and communication technologies (ICTs). This includes access to computers and the internet, which also require electricity access (Jain and Mutula 2001).

Most significantly, no quantitative evidence showed that electrification leads to better school performance. Although evaluations in other countries have shown that "infrastructure investments have a positive impact on school enrollment and attendance rates and learning achievement" (Al-Samarrai 2016), there are also prioritization concerns over what parts of the school to electrify and whether there are other things on which funds for electrification may be better utilized instead (Leitch, Scott, and Adams 1997), especially if improvement in learning outcomes are not evident. The study aims to help fill out these gaps.

Electrification and Internet Access in the Philippines

In his first State of the Nation Address held in July 2022, President Ferdinand Marcos, Jr. had this to say regarding education.

> Our children must always be equipped with the best that we can provide. . . . I am talking about materials that are necessary for effective teaching in this day and age. . . . Children now need connectivity to the internet; they need devices to use; they need computers, educational tools so that they might participate fully in the digital community here and abroad. (Marcos 2022)

President Marcos added that "universal connectivity will be a vital component in order to ensure that no citizen is left behind." Although President Marcos acknowledged the need for devices, additional educational tools, and some materials in his

2022 SONA, equipment and additional training had already been mentioned in DepEd Memorandum No. 059, series of 2019 titled, "Prioritizing the Development of the Last Mile Schools in 2021: Reaching Out and Closing the Gap."

The absence of electricity was among the indicators for determining whether a school belongs to what are called Last Mile Schools (LMS). Other LMS indicators include:

- Schools with less than four classrooms;
- Schools with makeshift or nonstandard rooms;
- Schools have not been allocated repairs or new construction projects in four years;
- Schools that are more than an hour's travel from the town center or situated on a difficult terrain;
- Schools with multigrade classes/rooms;
- Schools with fewer than five teachers;
- Schools with fewer than 100 students; and
- Schools with more than 75 percent of their student population being indigenous people (IP) learners (Department of Education 2019, Point 2).

DepEd prefaces its memorandum by pointing out that the agency "is sustaining the substantial gains in access to education through the provision of adequate education facilities, teaching and nonteaching personnel, and learning resources. However, gaps in resources and facilities still remain in schools that have not met the allocation criteria for various educational inputs" (DepEd Memo. 059 s. 2019, Point 1). The memorandum implies that addressing gaps in access to infrastructure, such as electricity and the internet, have contributed to gains in the sector and have implications for students' improved learning in schools with limited access to resources.

In line with this, DepEd intended to implement programs and projects to address the needs of LMS. These included the following electrification and information and communication technology-related items:

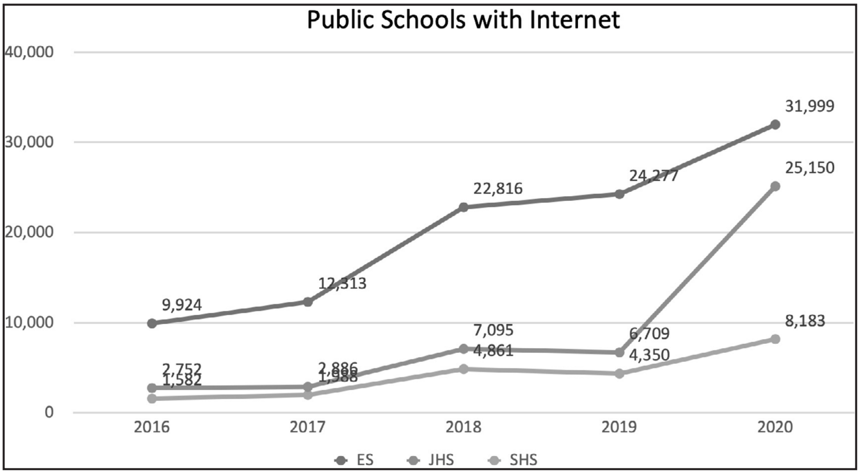
e. ...Installation of solar panels to energize the unenergized schools. . .
f. Delivery and installation of DepEd Computerization Program (DCP) packages;
g. Connection of the school to the DepEd Network and Internet Deployment of learning and administrative systems. . .
h. Provision of teaching and learning materials
i. Provision of Technology-Vocational-Livelihood (TVL), Science, and Mathematics equipment
j. Provision of additional teachers and training of existing teachers. (DepEd Memo No. 059, s. 2019, Point 5)...

These broad categories and projects can theoretically cover supplementary activities that can augment or be integrated with infrastructural interventions in developing LMS.

At the start of the pandemic in March 2020, DepEd (2020) conducted a survey among its teachers on their readiness for distance education. The department issued a memorandum with a survey template. The responses were then consolidated by DepEd's Planning and Research Unit of the School Division Offices (SDOs) and analyzed by its Central Office's Planning Service. DepEd then obtained responses from 787,066 teachers nationwide across various key stages of basic education (from kindergarten until senior high school). It was not explicitly stated whether the respondents were only from public schools.

DepEd found that 13 percent of teachers who responded (n = 737,066) did not have a computer at home. Among those who did have computers (n = 687,911), only 49 percent had Internet access at home. Sometimes, students and teachers gain intermediary access by using computers and the internet in schools and libraries.

Figure 1. Public schools with Internet from 2016 to 2020



Source: DepEd (2020)

In the Philippines, the number of public schools with internet access grew threefold from 2016 to 2020 (Figure 1), with the highest growth recorded in 2020. Despite this large increase, universal internet access is still far from being achieved (Table 1).

Table 1. Percentage of schools with Internet connectivity by region, S.Y. 2020–2021

Region	Elementary Schools (%)	Junior High Schools (%)	Senior High Schools (%)
I	83.3	85	74.9
II	80	85.6	78.6
III	77.6	85.3	78.7
IV-A	79	81.8	71.5
IV-B	69	76.4	77.7
V	46.4	60.7	55.9
VI	67.5	74.5	69.7

VII	58.2	73.9	66.7
VIII	54.9	61.1	60.1
IX	51.2	67.1	56.5
X	58.4	59.4	65.1
XI	54.9	58.9	65.3
XII	58.3	64.8	65.1
Caraga Administrative Region	54.1	69.4	60.4
Bangsamoro Autonomous Region in Muslim Mindanao (BARMM)	51.5	50.8	54.2
Cordillera Administrative Region (CAR)	76.2	75.4	69.2
National Capital Region (NCR)	97.9	95.4	73.5
National	64.2	72.2	67.3

Source: DepEd (2022)

More than 80 percent of public schools in all levels of basic education have functional computers. Furthermore, based on 2022 DepEd data, only 64 percent of elementary schools, 72 percent of junior high schools, and 67 percent of senior high schools had internet access. Furthermore, there remains a digital divide illustrated by the large variance in access from region to region, with NCR having 98 percent access for its elementary schools, versus only 51 percent in Region IX. However, evidence of the impact of ICTs and the internet has not been as convincing as that for electrification. The supposed promise that ICTs can bring better learning in primary and secondary schools has yet to be realized (Gamage 2018).

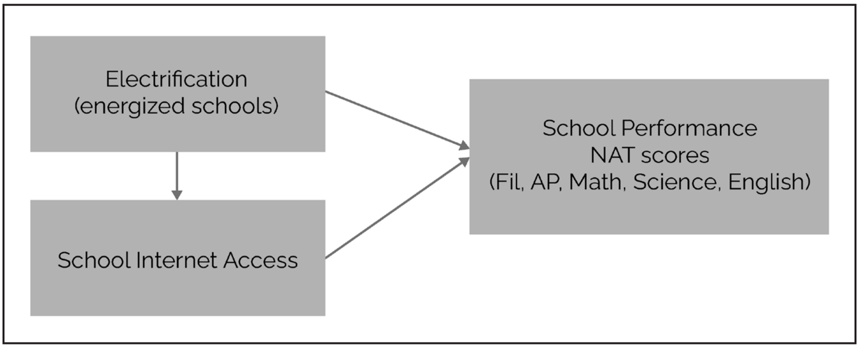
Quantitative Evidence for the Link Between Electrification and Internet Access with Better Education

This study is limited to investigating whether electrification and internet access lead to better education. It does this by evaluating whether improved access to basic infrastructure, such as electricity and internet services, led to better school performance among students taking the National Achievement Test (NAT) in the Philippines. Furthermore, given the access to NAT scores from DepEd, this study then revisits a set of schools with a known date of electrification and qualitatively evaluates them to see whether some differences in performance were seen over time. The study also compares electrified and unelectrified schools in terms of NAT performance, a contribution to an underdocumented area of development research. As mentioned above, there is little quantitative evidence on the link between electrification and internet access with better learning. Also, although this study's data was collected before the COVID-19 pandemic, quantitative evidence is still important in assessing the link between electrification and academic performance to help justify the budget that national agencies and local government units (LGUs) appropriated for electricity and internet access.

Conceptual Framework

Figure 2 illustrates the expected relationship between a school's electrification and internet access and its NAT results based on the literature discussed. The expectation is that in electrified schools, students perform better in the NAT. Furthermore, electrification is also needed to enable internet access, which may allow access to other educational services/applications and content (Cabotaje et al. 2021). The ability to access educational resources available on the internet can also translate to better school performance.

Figure 2. Evaluation framework on electrification, Internet access, and school performance



Electrification is operationalized in terms of the presence or absence of electricity in the school; internet access is also operationalized similarly. Meanwhile, school performance is based on their students' NAT scores in five subjects: Science, Mathematics, English, Filipino, and HEKASI (*Heograpiya*, *Kasaysayan*, at *Sibika* or Geography, History, and Civics).

Methodology

The education sector is a data-rich field where millions of data points are regularly created. However, only a fraction of the data government collects from the education sector are utilized for analysis. Using exploratory data analysis (EDA), an iterative, open-ended data analysis procedure, analysts and stakeholders examine data for the improvement of processes and make data-driven policies and decisions. EDA is conducted by assessing the data and exploring patterns. Visualizations are then used to show the relationship between data and features. Thus, using EDA becomes the first step to create models and statistical inferences (Chatfield 1986).

In this study, EDA was applied to data provided by DepEd by comparing electrified schools with unelectrified schools with respect to NAT scores from School Year (S.Y.) 2014–2015. This was the only DepEd data made available to the authors when the UP

CIDS DSPPP (Program on Data Science for Public Policy) Machine Learning Workshop was conducted.

The NAT, which was implemented in 2005, is a standardized test in the Philippines. It is "designed to determine pupils/students' achievement level" as the school year ends (Benito 2010). The NAT tests "strengths and weaknesses in five key curricular subject areas:" Science, Mathematics, English, Filipino, and *Heograpiya*, *Kasaysayan, at Sibika* (HEKASI) or Geography, History, and Civics in the elementary level or *Araling Panlipunan* (AP) or Social Studies in the secondary level (Department of Education 2005; Benito 2010).

Specifically, NAT "aims to provide empirical data on the achievement level of pupils/students in Grade 3, Grade 6 and second-year high school students," with this data forming the bases for key education stakeholders in decision-making, policy, and courses of action (Benito 2010). Since 2011, the NAT has been given to elementary students in Grades 3 and 6 and fourth-year high school students.

The NAT is still used with the current K-to-12 Basic Education curriculum, serving as an exit assessment of students in Grades 6, 10, and 12. NAT results are then used to determine if elementary, junior high schools, and senior high schools are achieving appropriate learning standards (DepEd 2009).

The EDA was also complemented by available panel data of NAT scores of selected elementary schools and a national high school that were known to be electrified by One Meralco Foundation, a nonprofit organization, from 2011 to 2013 (Cabotaje et al. 2021). Knowing when the schools were electrified, the researchers then compared the NAT scores of students from those schools before and after electrification using DepEd NAT data from S.Y. 2010–2011 to S.Y. 2014–2015. It should be noted, however, that different cohorts of students take the NAT tests from year to year.

Also, the analysis did not compare differences in access to the internet since information on when they had access to the internet was not available from that previous rural electrification study.

Data Description

DepEd's Information and Communication Technology Services (ICTS) provided 2015 data on Internet access, electric connectivity, location coordinates, enrollment, and teacher items of schools for 38,418 elementary schools and 7,957 secondary schools. Meanwhile, DepEd's Bureau of Educational Assessment–Education Research Division (BEA–ERD) gave NAT data, particularly a 10-percent stratified sampling of public schools nationwide of the 2011–2015 NAT takers. For this study, S.Y. 2014–2015 was considered because it shows internet, electricity, and NAT data. This sample was composed of 3,377 elementary schools and 736 secondary schools. Features that have no significance for the study were removed. Table 2 lists the different attributes and their data types below.

Table 2. 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 NAT scores: The average score of the school in the following subjects	Numeric: 0 to 100
Internet	Internet presence in schools	Binary: 0 (without internet) or 1 (with internet)
Energized	Presence of electricity in schools	Binary: 0 (without electricity) or 1 (with electricity)

Computational Environment

All analyses reported in this study were conducted using Python in Jupyter Notebook. Python is a "widely used high-level, general-purpose, interpreted, dynamic programming language" (Singh 2016a). Its core libraries, combined with its strength as a general-purpose programming language, make it ideal for advanced analytics. Specific packages used in this study were Numpy and Pandas for scientific computing and data analysis, and Matplotlib and Seaborn for plotting and visualizations (Python.org n.d.). All analyses were done in Jupyter Notebook, an "interactive computational environment, in which you can combine code execution, rich text, mathematics, plots, and rich media. These tools were used in data cleaning and transformation, numerical simulation, statistical modeling, and even machine learning (ML)" (Singh 2016b; Jupyter.org n.d.).

The study initially intended to employ ML algorithms to investigate whether some variables can predict NAT performance. ML refers to the automated detection of meaning patterns in data (Shalev-Shwartz and Ben-David 2014). However, available DepEd data was not sufficient to make this viable. Instead, the authors ended up performing EDA since it could already provide the insights needed for the study's objectives about NAT performance.

Education 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 2011). EDM and ML algorithms are already being utilized in research to predict the students' and schools' performance using various attributes or predictors.

Findings

School Electrification and NAT Performance

As of 2015, around 10 percent of the elementary school and three percent of the secondary school sample provided by DepEd were "unenergized," or did not have electricity. On average, elementary schools with electricity access (energized) performed 12 percent better than those that did not have electricity. For secondary schools, energized schools performed 10 percent better than unenergized ones (Figures 2 and 3).

Figure 3.1. Unenergized and energized elementary schools' NAT overall performance

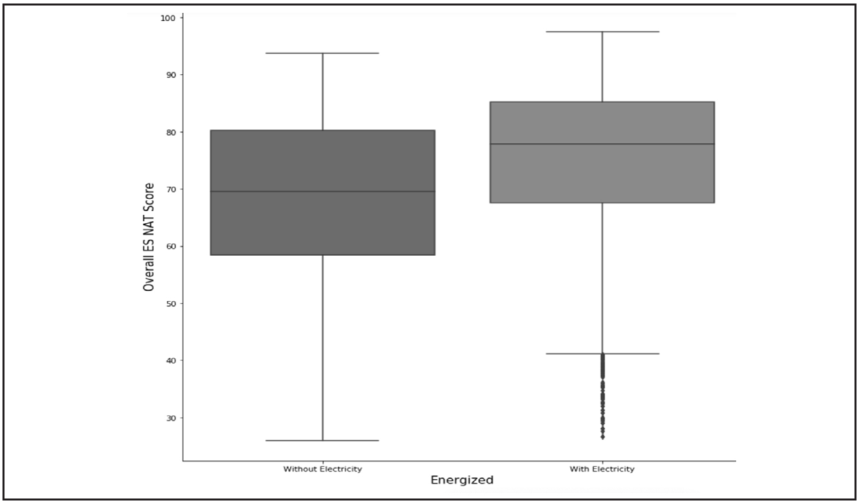
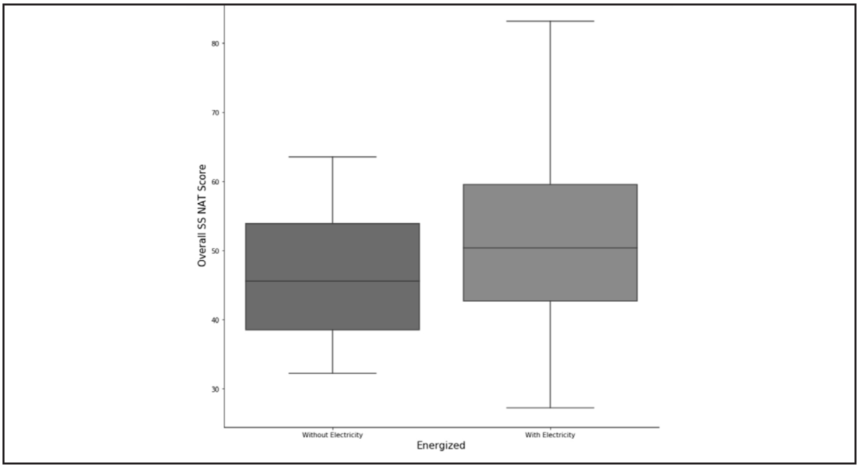


Figure 3.2. Unenergized and Energized Secondary Schools' NAT Overall Performance



Source: DepEd (2015)

When scores were disaggregated per subject, energized schools in both primary and secondary schools also performed better across all subjects (Tables 3 and 4).

Table 3. Median scores of unenergized and energized elementary schools on all NAT subjects

Median Score in	Filipino	Araling Panlipunan	Mathematics	Science	English
Unenergized	68.125	71.071	74.3293	65.2778	71.944
Energized	73.750	78.366	82.2638	75.3033	80.926

Source: DepEd (2015)

Table 4. Median scores of unenergized and energized secondary schools on all NAT subject

Median Score in	Filipino	Araling Panli-punan	Mathe-matics	Science	English	Critical Think-ing
Unenergized	54.574	43.256	40.516	36.558	43.210	39.375
Energized	59.644	49.153	51.770	47.424	45.616	43.182

Source: DepEd (2015)

Among the NAT subject scores, those for Science had a larger median improvement when the school is energized. Some hypotheses can be made for further study. For one, this score increase may mean that being energized means that more laboratory experiments can be performed by students, thereby increasing their learning. Another reason could be that energized schools also gain access to other supplementary multimedia materials, as experienced in documented cases of solar electrification in schools initiated by One Meralco Foundation (Cabotaje et al. 2021).

On Internet Connectivity

The tables and figures below show the median score and the percent difference (with internet versus without internet) for various NAT subjects of both elementary and secondary schools.

Table 5. Median scores of elementary schools with and without internet on all NAT subjects

Median Score in	Filipino	Araling Panlipunan	Mathematics	Science	English
With internet	73.333	78.047	81.443	75.381	80.432
Without internet	73.250	77.500	81.848	74.183	80.385
% difference	0.114	0.706	−0.494	1.616	0.059

Source: Department of Education (2015)

Table 6. Median scores of secondary schools with and without internet on all NAT subjects

Median Score in	Filipino	Araling Panli-punan	Mathe-matics	Science	English	Critical Think-ing
With internet	59.715	49.277	51.839	46.748	45.355	42.984
Without internet	58.859	47.743	50.600	48.164	46.278	44.356
% difference	1.456	3.211	2.449	−2.940	−1.994	−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, Critical Thinking in secondary schools). However, internet connectivity in the data is limited as it did not consider service quality (e.g., speed, bandwidth, reliability) since this may vary from region to region. Neither did it consider whether internet use was critical in the teaching of the subjects, which may have been the case in a pre-pandemic setting when remote learning was not the norm.

Table 7. Comparison of NAT scores of schools before and after electrification

Anonymized	Elem A	Elem B	Elem C	Elem D	HS A
Year of Electrification	2013	2013	2011	2012	2013
Filipino	89.78	86.22	77.41	79.38	49.69
Filipino After	77.83	76.11	77.46	68.29	51.49
Math	90.00	92.27	55.86	66.16	43.22
Math After	72.88	82.93	82.51	54.42	49.07
English	86.93	87.45	55.31	58.30	43.22
English After	72.88	82.93	71.52	51.93	44.98
Science	76.14	76.76	46.76	47.77	80.58
Science After	73.52	64.91	66.36	47.77	40.29
AP	84.55	81.96	73.77	75.00	51.87
AP After	76.02	69.97	75.62	58.88	50.60
Critical Thinking					48.44
Critical Thinking After					44.07
Overall	85.48	84.93	61.82	65.32	52.83
After	74.63	75.37	74.69	56.26	46.75

To control school location, the authors complemented the results with a panel study of NAT results for schools known to have been electrified through the corporate social responsibility (CSR) initiatives of a nonprofit organization. Then, the authors compared mean NAT results before electrification with mean NAT scores after electrification using DepEd data from S.Y. 2010–2011 to S.Y. 2014–2015.

The generated results were mixed, showing that most schools even had lower NAT scores after electrification. Only one of the four elementary schools showed a marked improvement in all the subjects and a better overall score. In one of the high schools, NAT scores improved in some subjects (Filipino, Mathematics, and English), but not in Science, Araling Panlipunan, and Critical Thinking.

The limitation to these results, however, is that the test takers were different for different years, and it is likely that the teachers who taught them might also have been different. The results did not also consider whether the use of other digital resources and ICTs was integrated into the teaching of the said courses.

Discussion

Findings from this assessment on the impact of electrification and Internet access are mixed. EDA results of DepEd schools show that electrified primary and secondary schools performed better than unelectrified schools in 2015. However, more evidence is needed, in terms of time-series data over the years, to show whether actual improvement occurred over time after electrification. For instance, in a complementary but limited panel data of five schools, where the year of electrification was known, there was no evidence of immediate improvement in NAT performance. This lack of supporting data reiterates the need to look at other systemic factors (e.g., teacher capabilities, curriculum, content, etc.) in the educational system that may also impact school performance. This also echoes the call for providing complementary services and activities for rural electrification projects (Peters et al. 2009). Some of these may be more clearly identifiable after the basic education sector implemented remote learning during the COVID-19 pandemic.

In addition, internet access does not seem to have a significant effect on NAT performance. Although this is also consistent with the literature, it may also be affected by differences in the quality of access across the country and perhaps a lag in its impact on learning.

Some also suggest that teachers' adoption and use of ICTs in the classroom are factors to consider in looking at ICTs' impact on learning outcomes (Gamage 2018). Although the LMS program does mention the development of other aspects, such as teaching resources and training, these variables were not available from the DepEd data provided for the EDA.

Recommendations

The government recognizes that there remain substantial gaps in resources and facilities in many public schools that have not met the allocation criteria for various educational inputs. Prior to the pandemic, it intended to close this gap by developing resources in LMS. This study's findings show that providing electricity in LMS is an important intervention.

The findings also have implications in prioritizing the provision and tracking of other types of LMS support, whether by the national government or local government units (LGUs) (through its Special Education Fund), especially in light of the limited resources for education (see Section 35[a–c] of the Implementing Rules and Regulations [IRR] of Republic Act No. 10533, or the "Enhanced Basic Education Act of 2013"). Clearly, given limited funds, electrification should be prioritized over internet access.

What the assessment has been unable to show, however, is the impact of internet access on NAT performance prior to the pandemic. Partly, this is because the digital divide among schools is not solely about internet access. It is also important to consider the capabilities and functions hopefully intended to accrue to the population, whether it is basic education or other government services, and take into account the users (e.g., teachers and students) and the other barriers preventing them from fulfilling their desired functions (Alampay 2006).

Although infrastructure access is crucial, true digital inclusion also requires not only access to needed ICTs (e.g., laptops) and learning platforms for teachers and students but also development of capacities for basic literacy complemented by digital literacy—all to achieve the benefits of digital transformation in education. Hence, the provision of internet access to schools will also require regular funding and financing of ICT devices, online content, and training for teachers and students alike. Funding for internet access and complementary ICTs and activities does not have be the national government's, through DepEd, sole responsibility. LGUs, especially now that they access more funds because of the Mandanas ruling, can also prioritize the funding of these needs (Alampay 2021).

Further research may be done on how internet connectivity is utilized in schools, particularly in how teachers integrate technology in teaching their subjects. Subsequently, as schools use more online content and applications, this will also require more bandwidth; hence, DepEd should also monitor internet access quality and project future demand requirements (e.g. bandwidth, data storage, among others) in all public schools. These are additional variables that DepEd could track as part of their efforts to raise LMS' level of instruction.

Like the experience with electricity, development impact may not be apparent nor can it materialize because of the absence in complementary services, policies, traditions, and power relations, among others (Matinga and Annegard 2013). For instance, future research relating internet connectivity to class school performance should consider whether internet use is actually necessary for their subjects, for which classes they (not) allowed, and how much time the class spends on the internet for these subjects. An example of the necessity of using internet content was how, over the course of the pandemic, more online materials have been used for teaching, whether for remote or blended learning and in synchronous and asynchronous sessions. However, its effectiveness, during the pandemic, has also been mixed at best (Muñoz-Najar et al. 2021).

Implications for the New Normal (Remote Learning)

DepEd Memorandum 059, s. 2019, which prioritizes LMS development, was written before the COVID-19 pandemic. As such, although the provision of infrastructure and utility requirements (i.e., electricity and the internet) was easy to measure and was documented in the data (e.g., either present or absent), other components (e.g., the number of schools within one-hour distance from the town center, with less than five teachers, and with more than 75 percent indigenous learners) were not available. The results of this EDA have shown the positive impact of electrification on NAT scores. However, they did not show any significant impact concerning internet access, even though this was based on prepandemic conditions.

Even though internet access did not show any significant difference, the NAT scores obtained therein were also from a time when the internet as a tool for instruction may not have been as crucial. New methods and content used during the pandemic are likely to affect how education is provided in the new normal. During the pandemic, access to ICTs and the internet was more crucial, since the country was on lockdown and remote or distance learning became the default. In the future, school closures should be minimized since this can have a long-term negative impact on school children and may lead to increased learning poverty incidence,[1] which was around 69.5 percent in the Philippines in 2019 (World Bank 2021). Furthermore, access to electricity is also essential to many remote learning modalities, particularly in rural areas (Jeon et al. 2021, 3).

The recent experience of the basic education sector during the pandemic actually helped further crystalize the complementary equipment, learning resources, and skills needed to incorporate online learning resources in basic education. Hence, for future EDAs, DepEd should also track additional information on the quality of internet access in terms of download/upload speed in schools, access to devices among teachers (e.g., laptops, or smartphones), ICT integration in

1 This is defined as "the share of 10-year-old children who cannot read and understand a simple story" (World Bank 2021).

their teaching (e.g., video conferencing applications, such as Zoom), various learning platforms available (e.g., Google Classroom), and online learning resources (e.g., videos; documentaries) they use.

However, the lack of access to ICTs and the Internet might be even more impactful, if taken from the context of the pandemic. In the Philippines, for instance, some distance learning modalities used digital and broadcasting formats (DepEd 2020). Hence, limited ICT access can lead to further marginalization among those affected by the digital divide, with those further marginalized possibly feeling more adverse effects of the period of disruption in education (Fontanos et al. 2020). Thus, reapplying the same EDA methodology on internet access may help capture the disadvantages caused by the pandemic among schools unable to shift to online remote learning, and those that were able to transition because of internet availability during the pandemic. In other words, the same EDA methodology can be applied to see differences in performance among students who have been able to continue with their education through online learning platforms and those who were unable to do so. In addition, performing a similar study in the future may be called for, considering how remote learning is becoming the norm, albeit using different modalities. The experience during the pandemic also suggests that aside from suitable technology, effective teachers and engaged learners are essential (Muñoz-Najar et al. 2021). It may be possible to test the effectiveness of these modalities as future pandemics may result in similar closure.

The recent pandemic has illustrated how a more robust education infrastructure, where more schools have electricity and internet access, is essential to making education more resilient, especially in case of similar disturbances in the future. Access, however, is not enough. For one, it cannot be assumed that there is ubiquity in the quality of access (Jeager et al. 2012). Even in the Philippines, some resources and tools require mobile devices like smartphones, and significant content and capabilities may not be compatible with these devices (and the types of access they have). The digital literacy of users—in this case, both teachers and students—would also be an important factor in how these are eventually translated as an effective medium for basic education.

Given the altered education landscape because of the pandemic, this study should also be seen as an opportunity to use more data analytics to measure students' performance as well as help the education sector and DepEd take better decisions through EDA and ML techniques. In this study, EDA was done to show the correlation of the variables with schools' performance in the NAT. Although this study did not employ EDM (Education Data Mining) and ML (Machine Learning) algorithms, EDM and ML techniques may be used to further identify the features or attributes that greatly contribute to the overall performance of schools in the NAT.

DepEd should make its education data on schools and school performance more open and accessible. This will allow researchers to increase the number of schools used in EDM and ML models and make results more robust and useful for policymakers. This will also help nurture an open data culture and encourage data use and analysis.

Conclusion

This evaluation of the impact of access to electricity and the internet in LMS was limited by its focus on the technological aspect of access. Future evaluations should also interrogate associated digital literacies and skills that may be required, as highlighted by recent experiences during the pandemic. For example, the capabilities to use learning platforms and find the correct information, among others, will also be important skills that make access more meaningful. Addressing both digital divides and literacies will be important in establishing digital inclusiveness in the new normal. Measuring needed literacies will also be needed to determine whether digital inclusiveness leads to better learning outcomes.

President Marcos mentioned the need to invest in infrastructure (energy and broadband, in particular) in his first SONA. However, to paraphrase past lessons from ICTD (and this research as well), ICTs are not magic bullets. Although they can make a good government better, they cannot make a bad government good (or, in this case, make a bad educational system good). The challenge of making other aspects of the Philippine educational system better remains. Without doing so, no amount of investment in infrastructure (electricity and ICTs) will solve the learning deficits in Philippine basic education.

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