Asia Pacific Journal of Advanced Education and Technology
Volume 2, Issue 2, June 2023 / P- ISSN 2815 – 245X / E – ISSN 2815 – 2468 / www.apjaet.com

Digital Resources' Availability, Usage, and Sufficiency: Insights from Filipino Scientific Literacy Scores

Roberto L. Rodriguez Jr.[1], Marie Grace S. Bulanadi [2], Adonis P. David[3]
rodriguez.rl@pnu.edu.ph
[1]Department of Mathematics and Sciences, Technological University of the Philippines-Cavite, Dasmariñas City,Cavite, Philippines
[2]Grade School, Espiritu Santo Parochial School, Sta. Cruz, Manila, Philippines
[3]Philippine Normal University-Manila, Taft Avenue, Manila, Philippines

DOI: https://doi.org/10.54476/apjaet/10645

Abstract

This study examined how the Filipino science test scores in the Programme for International Student Assessment last 2018 are predicted by (a) gender and type of school as covariates, (b) availability of digital resources in school, and support for teachers' digital instruction; and (c) availability and sufficiency of digital resources at learner's home. These objectives are attained by following a descriptive-correlational design that utilized publicly accessible data of the PISA 2018 results on the OECD website. Findings of the regression analysis unveiled that sex did not conclusively predict the scores while learners from private institutions perform better. Additionally, the availability of digital resources in school and their sufficiency at home positively predictedthe science scores, whereas the school's support for teachers' digital instruction and the availability of digital resources at home negatively predicted science scores. The availability and sufficiency of such digital devices for students at home were seemingly contradicting, hence, requiring further investigation in future studies.

Keywords: *Filipino learners, OECD, PISA 2018, science achievement, science learning*

Introduction

It is of paramount importance for education leaders to continuously improve their education system and provide quality, competitive education worldwide. Attaining such a goal is the centerpiece of the United Nations' Sustainable Development Goal #4, that is, to ensure a quality education for all that promotes inclusivity, equitability, and lifelong opportunities for all learners (Ferri, 2010; Opertti et al., 2017)." To monitor the inclination toward this goal by various educational systems, educational leaders subject their learners to large-scale standardized assessments nationally or internationally (Rodriguez, 2020). As one of the countries to hold to UNSDG #4, the Philippines commendably partook for the first time in the Programme for International Student Assessment (PISA) last 2018 despite the educational reforms its system had undergone (Alinsunurin, 2021; Balagtas, 2020).

The Philippines' Department of Education (DepEd) took a bold step in participating in PISA 2018 for it entails putting the K to 12 basic education curriculum through the 15-year-old students administered by the Organization for Economic Co-operation and Development (OECD) (Balagtas, 2020; OECD, 2019 a; Trinidad, 2020). Now on its seventh cycle, PISA 2018 is a triennial assessment that aimed to assess how 15-year-old learners had acquired the necessary knowledge and skills to cope with the dynamic demand of contemporary societies (OECD, 2019a) and to provide various states an insight into the quality education of other contexts around the globe (Schleicher, 2019). Particularly, it focused on examining the three core basic education subjects namely reading, mathematics, and science on top of an innovative domain that varies every three years (OECD, 2019a).

Last December 2019, results on these core subject domains were released publicly with data accessible on the OECD Website. Results unveiled the poor performance Philippines which ranked lowest in reading and second to the last for both mathematics and science among 79 countries (Orbeta et al., 2020, p.6; Rodriguez, 2020). The country contributed the biggest chunk (71.8%) to the number of low-performer learners and the smallest chunk to the number of high-performer learners among these countries without underlying reasons (Alinsunurin, 2021; Besa, 2019). These results raised red flags for educators, education leaders, and DepEd (DepEd, 2019; Rodriguez, 2020). Having the opportunity to access publicly available data, researchers initiate to uncover factors that can constitute the poor performance of 15-year-old Filipino learners from such as curricular misalignment (Balagtas, 2020), socioeconomic status (Bernardo, 2020; Gamazo & Martínez-Abad, 2020), growth mindset (Bernardo, 2020), school climate, material resources in school, gender, and type of school (Trinidad, 2020), parental involvement and life satisfaction among others (Orbeta et al., 2020). Moreover, reports have shown similar variables as significant factors influencing the performance of the participants in these domains (Besa, 2019; OECD, 2019b, 2019d, 2019c, 2020). However, quantitative studies focused on the factors that impact scientific literacy in PISA 2018 remain scarce.

As defined by OECD (2019, p. 15), a scientifically literate learner can "*engage in reasoned discourse about science and technology, which requires the competencies to explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically*." There is a long list of means to supplement the improvement of scientific literacy of learners fitting such standards. From this list, the rapidly advancing technology through the access to digital resources is relatively stale to result in positive effects (Millanes et al., 2017) that society was labeled not to function normally without it (Northern Kentucky University, 2018). Further, this has been supplementing teaching and learning processes which have affected pedagogies as well as collaboration among students in and out of the classroom (Yang & Baldwin, 2020). Particularly, in science teaching and learning, these digital resources have highlighted promising impacts on various constructs of education (Cavus & Alhih, 2014; Mercado et al., 2019). Hence, access to these resources and integration are highly valued in science education. Nevertheless, studies focused on the availability and sufficiency of these resources in school for both teachers and learners and at home for learners interplaying to its impact on the standardized science cognitive test score of Filipino learners in PISA 2018 remain insufficient. Hence, this study is conducted.

Objectives of the Study

Aiming to fill in the insufficiency in the literature, this study specifically aimed to determine how the standardized science cognitive test score of Filipino learners in PISA 2018 is predicted by (a) gender and type of school as covariates, (b) availability of digital resources in school, and school's support for teachers' digital instruction; and (c) availability and sufficiency of digital resources at learner's home.

Methodology

Data and measures. The study followed a non-experimental quantitative research design. Specifically, it followed a descriptive-correlational design that utilized publicly accessible data of the

PISA 2018 results on the OECD website. Due to incomplete input data, the total number of schools was reduced to 186 Philippine high schools from the 17 regions of the country which were sampled using stratified sampling (Besa, 2019). These sampled schools were composed of 153 (82.26%) public and 33 (17.74%) private high schools. Meanwhile, the data were trimmed to a total of 6527 Filipino high school learners aged 15 consisting of 3492 (53.50%) females and 3035 (46.50%) males. However, not all the 15-year-old participants were attending the formal school system during the time of the administration (Trinidad, 2020).

From various questionnaires, the researchers consolidated the input data from the student-level and school-level questionnaires completed by learners and school principals, respectively. The answers of the students were accounted for as student-level data composed of Sex, standardized science literacy score, availability, and sufficiency of digital resources at home. On the other hand, the answers of the school principals were accounted for as school-level data consisting of school type, availability of digital resources in school, and schools' support for teachers' digital instruction in terms of the capacity to enhance the teaching and learning process.

School-level independent variables. Aimed to explore how digital resources in schools influence science literacy, the researchers identified items that constitute the availability of digital resources in schools and schools' support for teachers' digital instruction concerning the teaching and learning process. Particularly, the researchers combined scores that school principals indicate in terms of their perception of the extent that the availability of digital resources in school and schools' support for teachers' digital instruction in enhancing learning and teaching. Items that constitute these school-level data were combined to emphasize more reliable data compared to item-level data (Trinidad, 2020). Responses range from 1 (Strongly disagreeing to contribute to the enhancement of teaching and learning using digital devices) to 4 (Strongly agreeing to contribute to the enhancement of teaching and learning using the digital device). Table 1 shows specific items lumped for each school-level independent variable.

Student-level independent variables. Aimed to explore how digital resources at home influence science literacy, the researchers identified items that constitute the availability and sufficiency of digital resources at home that learners can use for school tasks. The learners' responses to the identified items were lumped holding the same principle of being more reliable than treating them at an item level (Trinidad, 2020). For the availability of the digital resources, students ticked 1 (Yes) if the enumerated resource is available at home, otherwise, 2 (No). On the other hand, responses on the sufficiency of the digital resources recorded in terms of the number were 1 for none, 2 for one, 3 for two, and 4 for three or more of the listed digital resources.

Dependent variable. In this study, the standardized science cognitive test score from PISA 2018 results served as the dependent variable. These scores were labeled as plausible values (PVs) which do not indicate the actual test score of the student participants but are values randomly drawn from the posterior distribution for the cognitive component (Bernardo, 2020; Jerrim et al., 2017; Trinidad, 2020). For each learner, ten PVs are not intended for individual estimation (OECD, 2009). For the analysis in the current study, the researchers utilized odd-number PVs for science (PV1, PV3, PV5, PV7, PV9).

Covariates. It has been established in a recent study that students' Sex turned out to be correlated with science test scores on average and in quartile regression analysis (Orbeta et al., 2020) and to have a statistically significant correlation with test scores in reading and mathematics literacies (Trinidad, 2020). Further, it was revealed in the study of Trinidad (2020) that learners' being in private school has a significant positive correlation with their reading and mathematics scores. Hence in the current study, students' sex and type of school were added as the dichotomous covariate control variable in this investigation. For the Sex, 1 was assigned for female learners and 2 for male learners while for the type of school, 1 was assigned if the learners' school is public and 2 if otherwise.

Data analysis. To explore how the digital resources in school and at home are associated with the standardized science cognitive test score from PISA 2018 results, a hierarchical regression analysis was administered. Each PV was first regressed to Sex and type of school control variables in model 1. In model 2, the school-level independent variables were added. Lastly, student-level independent variables were added in model 3. At each step, the resulting model and the explained variance in terms of R^2 of the model were assessed.

Table 1
Item constituting the clustered independent variables.

Independent Variables	Main Question	Questions
School-level, n = 186		
Availability of digital resources in school	to what extent do you agree with the following statements about your school's capacity to enhance learning and teaching using digital devices?	The number of digital devices connected to the Internet is sufficient
		The school's Internet bandwidth or speed is sufficient
		The number of digital devices for instruction is sufficient
		Digital devices at the school are sufficiently powerful in terms of computing capacity
		The availability of adequate software is sufficient
Support for teachers' digital instruction		Teachers have the necessary technical and pedagogical skills to integrate digital devices in instruction
		Teachers have sufficient time to prepare lessons integrating digital devices
		Effective professional resources for teachers to learn how to use digital devices are available
		An effective online learning support platform is available
		Teachers are provided with incentives to integrate digital devices into their teaching
Student-level, n = 6527		
Availability of digital resources at home	Which of the following are in your home?	A computer you can use for schoolwork
		Educational software
		A link to the Internet
Sufficiency of digital resources at home	How many of these are there at your home?	<Cell phones> with Internet access (e.g., smartphones)
		Computers (desktop computer, portable laptop, or notebook)
		<Tablet computers> (e.g., <iPad®>, <BlackBerry® Playbook>)
		E-book readers (e.g., <KindleTM>, <Kobo>, <Bookeen>)

Source: Programme for International Student Assessment 2018 (Philippines)

Results and Discussion

1. Descriptive statistics

Table 2
Descriptive statistics of key research variables.

	Min	Max	Mean	SD
School-level Independent Variables				
Availability of Digital Resources in School	1.00	4.00	2.35	0.75
School's Support for Teachers' DigitalInstruction	1.20	4.00	2.78	0.53
Student-level Independent Variables				
Availability of Digital Resources at Home	1.00	2.00	1.56	0.38
Sufficiency of Digital Resources at Home	1.00	4.00	1.87	0.60
Science Standard Cognitive Test Scores				
PV 1	149.58	668.80	360.08	73.51
PV 3	172.33	650.16	360.63	74.83
PV 5	151.80	684.28	359.69	75.55
PV 7	133.09	649.78	360.51	75.34
PV 9	136.62	657.91	358.18	74.83

The descriptive statistics of the variables used in the study are summarized in the table above. It can be discerned that based on the weighted mean of 2.35, school principals were leaning towards disagreeing that the available digital resources in their schools are capable of enhancing teaching and learning using these resources. On the other hand, the weighted mean of 2.78 showed that school principals were inclined to agree that their institution's support for teachers' digital instruction capacitates the school to enhance teaching and learning using these digital resources.

Meanwhile, the aggregated mean score of 1.56 signifies that the bigger chunk of Filipino learners who took PISA 2018 had no access to a computer, educational software, and link to the internet that they can use for schoolwork. In terms of the sufficiency of digital resources, it can be gleaned from the computed mean of 1.87 that these learners have an average of none to one of the resources namely cellular phones with Internet access, computers, tablet computers, and e-book readers.

Lastly, it can be observed that the mean values of chosen PVs were slightly higher than the 357 Philippine mean scores in science yet lower than the 489 OECD average reported in Besa (2019) suitable as the values to represent the dependent variable in the study.

2. Regression analysis

Relevant to the main objectives of the current study, the result of the 3-step hierarchical regression analysis between standardized science cognitive test scores from PISA 2018 and digital resources at home and in school was summarized in Table 3 below The significant predictors were determined at 0.05, 0.01, and 0.001 levels of significance.

In step 1, sex and the type of school were first regressed to all odd-numbered PVs from PISA 2018. The type of school positively predicted the performance in science. The overall regression model was significant for all PVs yet the explained variances with R^2 and adjusted R^2 ranged from 0.05 to 0.06, respectively.

Table 3
Hierarchical regression analysis of science literacy and digital resources in school and at home

Predictors	PV 1			PV 3			PV 5			PV 7			PV 9		
	β	R^2	F	β	R^2	F	β	R^2	F	β	R^2	F	β	R^2	F
Model 1															
Sex	-0.02	0.05	166.85	-0.03^{b}	0.05	169.46	-0.01	0.06	212.98	-0.04^{c}	0.05	186.04	-0.04^{c}	0.06	210.34
Type of School	0.22^{c}			0.22^{c}			0.25^{c}			0.23^{c}			0.24^{c}		
Model 2															
Sex	-0.02	0.07	124.54	-0.04^{b}	0.07	120.21	-0.01	0.08	136.74	-0.04^{c}	0.07	129.68	-0.04^{c}	0.08	133.62
Type of School	0.15^{c}			0.15^{c}			0.19^{c}			0.16^{c}			0.18^{c}		
Availability of Digital Resources in School	0.19^{c}			0.18^{c}			0.17^{c}			0.17^{c}			0.16^{c}		
School's Support for Teachers' Digital Instruction	-0.04^{b}			-0.05^{c}			-0.05^{c}			-0.02			-0.04^{b}		
Model 3															
Sex	-0.01	0.13	162.32	-0.03^{a}	0.13	164.73	-0.01	0.13	167.81	-0.04^{b}	0.14	172.26	-0.03^{b}	0.13	161.74
Type of School	0.08^{c}			0.09^{c}			0.13^{c}			0.09^{c}			0.12^{c}		
Availability of Digital Resources in School	0.17^{c}			0.16^{c}			0.15^{c}			0.15^{c}			0.14^{c}		
School's Support for Teachers' Digital Instruction	-0.05^{c}			-0.06^{c}			-0.06^{c}			-0.03^{a}			-0.05^{c}		
Availability of Digital Resources at Home	-0.06^{c}			-0.08^{c}			-0.07^{c}			-0.08^{c}			-0.06^{c}		
Sufficiency of Digital Resources at Home	0.22^{c}			0.22^{c}			0.21^{c}			0.22^{c}			0.21^{c}		

$^{a}p \leq .05$. $^{b}p \leq .01$. $^{c}p \leq .001$.

In addition, similar patterns in the covariates were evident throughout the 3-step hierarchical regression analysis. In terms of sex, there was an incoherent significant difference as a covariate variable. Hence, it is inconclusive to interpret that either of the sexes outperforms the other in terms of scientific literacy. Such an incoherent result is consistent with the report of Besa (2019) on the general report of the Philippines' performance in PISA 2018 and Bernardo (2020) which reported this using PV1. Meanwhile, a consistently significant difference ($p \leq .001$) was revealed in terms of the type of school. Beyond the results, the t statistic for each PV shows a more positive value which revealed that learners from private institutions perform better in science. A similar observation was reported by Trinidad (2020) in terms of Filipino learners' performance in reading and mathematics. Hence, the direct impact of the identified covariates in the study was partially observed in step 1.

Proceeding to step 2, the school-level data in terms of digital resources were added to the regression equation. The overall regression model was significant for all PVs yet the explained variances with R^2 and adjusted R^2 ranged from 0.07 to 0.08, respectively. This means that the variation in science literacy can be explained by the school-level data in a small portion (7% to 8%) when added to the regression equation. The change from step 1 to step 2 was statistically significant ($p \leq .001$). In addition, similar patterns in the school-level data were evident from steps 2 to 3 in the hierarchical regression analysis. The regression analysis indicated that the availability of digital resources in school positively predicted the standardized science cognitive test score in PISA 2018. This underscored that the degree of agreement of the school principals on the school's capacity to enhance teaching and learning using the available digital devices significantly impacts the science performance of learners in standardized tests. The result is consistent with the reported result of OECD (2020), from a global point of view, that schools with digital resources contribute positively to the academic performance of learners given that established policies are present. Further, this was asserted by Cavus & Alhih (2014) and Hanushek & Woessmann (2017) highlighting that access to technology in the teaching and learning process promotes promising effects on scientific literacy skills.

Interestingly, the majority of the results of the regression analysis revealed that the school's support for teachers' digital instruction negatively predicted the standardized science cognitive test score in PISA 2018. This accentuated that the degree of agreement of the school principals on the school’s capacity to enhance teaching and learning by using the available digital devices to support teachers’ digital instruction inversely impacts the science performance of learners in standardized tests. This result contradicts the implications in Table 2 and the conception that the support for technology-integrated instruction positively affects the students’ understanding of science concepts (Mercado et al., 2019; Tan et al., 2020; Tosh et al., 2020). Knowing this variable as a negative predictor opens a venue for education researchers to assess its consistency with other large-scale assessment results, hence, highlighting the importance of educational assessment in similar investigations (Magno, 2010).

Lastly, in step 3, the student-level data in terms of digital resources were added to the regression equation. The overall regression model was significant for all PVs yet the explained variances with R^2 and adjusted R^2 ranged from 0.13 to 0.14, respectively. This means that the variation in science literacy can be explained by the student-level data in a small portion (13% to 14%) when added to the regression equation. The change from step 2 to step 3 was statistically significant ($p \leq .001$). In addition, in model 3, all school-level and student-level data had a statistical impact on the standardized science cognitive test score from PISA 2018. It can be gleaned from that the availability of digital resources at home negatively predicted scores for the plausible values in science. This result contradicted the idea that having access to digital resources at home will put a learner at an advantage (Loveless, 2021). As a dichotomous variable with “Yes” (1) or “No” (2) as responses, the t statistic for each PV shows a more negative value which underscored that those learners with digital resources at home performed better than those without access to digital resources at home. Conversely, the sufficiency of the digital resources at the home of the learners positively predicted scores for the plausible values in science. This highlighted that the more digital devices available at home for learners in doing schoolwork, the better the performance of learners in science standardized tests. The availability and sufficiency of such digital devices for students at home were seemingly contradicting, hence, requiring further investigation in future studies. These results can be attributed to the need to further investigate the substantial incorporation of these resources into learners’ learning strategies (Dowell and Small, 2011) over the limitation of this study on just quantifying these resources.

Conclusions

The underperformance of 15-year-old Filipino learners in the scientific domain of PISA 2018 has raised red flags to educational researchers and leaders in the investigation of predictive factors for these results. Yet less is known about the interplay between the standardized science cognitive test score of Filipino learners in PISA 2018 and digital resources at home and school. Hence, this study examined how the standardized science cognitive test score of Filipino learners in PISA 2018 is predicted by (a) gender and type of school as covariates, (b) availability of digital resources in school, and school’s support for teachers’ digital instruction; and (c) availability and sufficiency of digital resources at learner’s home.

The descriptive analysis of school-level variables revealed school principals are leaning to disagree that the availability of digital resources in schools enhances the learning process while confirming that their support for teachers' digital instruction to enhance the teaching and learning process is in place. Meanwhile, student-level independent variables showed the inaccessibility of these resources for learning use. The chosen science standard cognitive test scores were higher than the Philippines' reported mean score but lower than the OECD average. Further, findings of the 3-step hierarchical regression analysis with covariate variables unveiled that sex did not conclusively predict the science scores while learners from private institutions perform better in PISA 2018. Lastly, the availability of digital resources in school and the sufficiency of digital resources at home positively predicted the science scores, whereas the school's support for teachers' digital instruction and the availability of digital resources at home negatively predicted science scores.

It can be gleaned from that unlike previous studies, learners' sex does not categorically describe one's science academic performance while one's type of school does. This precedes the thought of having a difference in the implementation of the curriculum between private and public institutions using digital resources for science curricula relative to students' cognitive preparation for large-scale assessments like the PISA. Not to mention, the private institutions' capability to provide access to these resources for their learners has been palpable. It is interesting to highlight that the availability and sufficiency of these resources at home predicted the score differently. These results heighten the prevalence of the digital divide and how their learning environment on accessing these resources affects them. Once learners are in the comforts of their homes, the access to these resources may be treated differently and their sufficiency may be taken for granted. This puts those who have limited access to these resources in school in an incommodity. Meanwhile, while studies support how teachers' integration of digital resource bolster the science teaching and learning process, teachers still need support on the necessary skills in fully incorporating them in the process initiated by the institutions to which they belong. This calls for the urgency for school leaders to look at what happens at the grassroots in terms of utilizing these resources. That is, the availability of digital resources for teachers' use is a good investment to pave the way to backing the teachers in optimizing them to the learning environment.

Recommendations

As recommendations, school leaders can capitalize on the result of the study on how to enhance the support system for teachers' digital instruction. Moreover, stakeholders can put up a communal effort in encouraging learnersto maximize access to these digital resources at home and school. Further, future researchers can extend the investigation to various large-scale assessments to check the consistency of the results of the study at hand. Lastly, theycan also explore how these variables can potentially predict other plausible values for Mathematics and English inthe same large-scale assessment result.

References

Alinsunurin, J. (2021). Unpacking underperformance: Learning mindsets and the challenge of academic achievement among filipino students. *SSRN Electronic Journal*, *June*. https://doi.org/10.2139/ssrn.3867956

Balagtas, M. U. (2020). Executive summary: analysis of the PISA framework vis-à- vis the Philippine K to 12 Curriculum. In *M.U. Balagtas & MA. C. Montealegre (Eds), Challenges of PISA: The PNU Report*. Philippine Normal University.

Bernardo, A. B. I. (2020). Socioeconomic status moderates the relationship between growth mindset and learning in mathematics and science: Evidence from PISA 2018 Philippine data. *International Journal of School and Educational Psychology*, 1–16. https://doi.org/10.1080/21683603.2020.1832635

Besa, F. (2019). *Philippines country note. Programme for International Student Assessment (PISA). Results from PISA 2018*

Cavus, N., & Alhih, M. S. (2014). Learning management systems use in science education. *Procedia - Social and Behavioral Sciences*, *143*(February 2014), 517–520. https://doi.org/10.1016/j.sbspro.2014.07.429

DepEd. (2019). *PISA 2018: National Report of the Philippines*. 1–43.

Ferri, N. (2010). United nations general assembly. *International Journal of Marine and Coastal Law*, *25*(2), 271–287.https://doi.org/10.1163/157180910X12665776638740

Gamazo, A., & Martínez-Abad, F. (2020). An exploration of factors linked to academic performance in PISA 2018 through data mining techniques. *Frontiers in Psychology*, *11*(November), 1–17. https://doi.org/10.3389/fpsyg.2020.575167

Hanushek, E. A., & Woessmann, L. (2017). School resources and student achievement: a review of cross-country economic research. *M. Rosen et Al. (Eds) Cognitive Abilities and Educational Outcomes*, 149–171. https://doi.org/10.1007/978-3-319-43473-5

Jerrim, J., Lopez-Agudo, L. A., Marcenaro-Gutierrez, O. D., & Shure, N. (2017). What happens when econometrics andpsychometrics collide? An example using the PISA data. *Economics of Education Review*, *61*(February), 51–58. https://doi.org/10.1016/j.econedurev.2017.09.007

Loveless, B. (2021). *The importance of digital literacy in K-12*. Education Corner. https://www.educationcorner.com/importance-digital-literacy-k-12.html

Magno, C. (2010). A brief history of educational assessment in the Philippines. *Online Submission*, *1*(July), 140–149.Mercado, J. N. L., Panganiban, V. J. M., & Ramos, T. M. I. (2019). Technology Integration in Teaching Science Using

TPACK among pre-service science teachers of St . Bridget College, Batangas City, Philippines. *IOERInternational Multidisciplinary Research Journal*, *1*(1), 63–71.

Millanes, M. A. A., Paderna, E. E. S., & Que, E. N. (2017). Podcast-integrated physics teaching approach : Effects on student conceptual understanding. *The Normal Lights*, *11*(2), 60–85.

Northern Kentucky University. (2018). *Study technology's effect on society*. https://onlinedegrees.nku.edu/articles/sociology/technologys-effect-on-society.aspx

OECD. (2009). PISA data analysis manual: SPSS® SECOND 2nd Edition. In *OECD Publishing*. http://books.google.co.uk/books?id=FcLxd_sOkHEC%5Cnhttp://www.oecd-ilibrary.org/education/pisa-data-analysis-manual-spss-second-edition_9789264056275-en

OECD. (2019a). PISA 2018 Assessment and analytical framework. In *OECD Publishing*. https://doi.org/https://doi.org/10.1787/b25efab8-en

OECD. (2019b). PISA 2018 Results (Volume I): What students know and can do. In *OECD Publishing: Vol. I*. https://www.oecd-ilibrary.org/education/pisa-2018-results-volume-iii_acd78851-en%0Ahttps://www.oecd.org/pisa/publications/PISA2018_CN_IDN.pdf

OECD. (2019c). PISA 2018 Results (Volume II): Where all students can succeed. In *OECD Publishing: Vol. II*. https://www.oecd.org/pisa/publications/PISA2018_CN_IDN.pdf

OECD. (2019d). *PISA 2018 Results (Volume III): What school life means for students' lives: Vol. III*. https://www.oecd-ilibrary.org/education/pisa-2018-results-volume-iii_cd52fb72-en

OECD. (2020). PISA 2018 Results (Volume V): Effective policies, successful schools. In *OECD Publishing: Vol. V*. https://doi.org/https://doi.org/10.1787/ca768d40-en.

Opertti, R., Kang, H., & Magni, G. (2017). *Comparative analysis of the national curriculum frameworks of five countries : Brazil, Cambodia, Finland, Kenya, and Peru*. *18*. https://unesdoc.unesco.org/ark:/48223/pf0000263831

Orbeta, A. J. C., Melad, K. A. M., & Potestad, M. (2020). Correlates of test performance of 15-year-old students in the Philippines : Evidence from PISA. *Philippine Institute for Development Studies*, 1–31. https://www.pids.gov.ph

Rodriguez, R. J. L. (2020). Brazening the new normal: flexible tools for empowering science pedagogical approaches. *Academia Lasalliana Journal of Education and Humanities*, *1*(2), 11–26. https://portal.dlsud.edu.ph/research/DetailView.aspx?ContentID=1032

Schleicher, A. (2019). PISA 2018: Insights and interpretations. In *OECD Publishing*. https://www.oecd.org/pisa/PISA2018 Insights and Interpretations FINAL PDF.pdf

Tan, C. Y., Liu, P., & Wong, W. L. V. (2020). Different patterns of relationships between principal leadership and 15- year-old students' science learning: How school resources, teacher quality, and school socioeconomic status make a difference. *Frontiers in Psychology*, *11*(August), 1–19. https://doi.org/10.3389/fpsyg.2020.02257

Tosh, K., Doan, S., Woo, A., & Henry, D. (2020). Digital instructional materials: What are teachers using and what barriers exist? *Digital Instructional Materials: What Are Teachers Using and What Barriers Exist?* https://doi.org/10.7249/rr2575.17

Trinidad, J. E. (2020). Material resources, school climate, and achievement variations in the Philippines: Insights from PISA 2018. *International Journal of Educational Development*, *75*(February), 102174. https://doi.org/10.1016/j.ijedudev.2020.102174

Yang, D., & Baldwin, S. J. (2020). Using technology to support student learning in an integrated STEM learning environment. *International Journal of Technology in Education and Science*, *4*(1), 1–11. https://doi.org/10.46328/ijtes.v4i1.22

Copyrights