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Article

Access of Information, Communication, and Technology (ICT) and Learning Performance of Junior High School Students in Indonesia: Analysis at the District Level

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Abstract

One of the goals of educational development is that education must be accessible to everyone. Both accessibility and quality of education have to be attained to assure human resource development. Unfortunately, the academic achievement of Indonesian students in recent years is still unsatisfactory. Meanwhile, the development of Information and Communication Technology (ICT) is inseparable from human life. ICT has become one of the solutions to improve educational quality. This study aims to analyze the effect of ICT access on the learning performance of Indonesian junior high school (SMP) students. ICT access in this study focuses on basic facilities and infrastructure that schools must possess based on indicators of sustainable development goals, namely availability of computers, access to the internet, and electricity. This study uses cross-sectional data from regencies/cities in Indonesia in 2018 with the Ordinary Least Square (OLS) model based on the theoretical framework of education production functions using Computer-Based National Examination (UNBK) data as a dependent variable. Study results show that the availability of computers in schools and ICT facilities in households has a significant positive effect on the learning performance of SMP students in Indonesia. Meanwhile, the availability of access to electricity and school internet has not affected the learning performance of SMP students. The independent control variables of school characteristics (the student-to-teacher ratio and class conditions) and socioeconomic characteristics (population density) show significant positive results on the learning performance of SMP students. National examination scores in Eastern Indonesia tend to be lower than those in other regions. In this regard, the government needs to focus on the improvement and equity of ICT resources.

Keywords: ICT; learning performance; computer-based national examination.

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I. Introduction

1.1. Background

Education is the key to development and one of the basic needs for a person to improve self-quality to improve their welfare in the future. As educational development aims to ensure quality education that is inclusive and equitable for all citizens, education must be accessible to everyone as mandated in Article 31 of the 1945 Constitution. Education that is qualified and evenly distributed can bring a positive impact on sustainable economic growth (Acemoglu & Robinson, 2012). However, Indonesia's biggest challenge in education services is not only to provide equitable access to education but also to improve educational quality and competitiveness of Human Resources (HR). It serves as a challenge since Indonesia is an archipelagic country and home to more than 250 million people spanning over 17,504 islands (Statistics Publication of Statistics Indonesia (BPS), 2017). Differences in socioeconomic conditions in regencies/cities can affect their capacity to provide education services and affect educational outcomes (Worldbank, 2020).

The report from UNESCO's Global Education Monitoring (GEM) (2016) shows that social inequality has increased over the past two decades, which calls for improvements in education. This inequality in a broader context can weaken a country to compete globally. Indonesia's rank in the 2018 Programme for International Student Assessment (PISA) report released by the Organisation for Economic Co-operation and Development (OECD) shows that the quality of education in Indonesia is relatively low. PISA is an international test held every 3 (three) years to examine the literacy performance of 15-year-old school students in reading, mathematics, and science.

Table 1. Indonesia PISA Score Results from 2009 to 2018

Indonesia PISA Score	2009	2012	2015	2018	Minimum Competency Level Score Standard (Level 2)
Reading	402	396	397	371	407
Mathematics	371	375	386	379	420
Science	383	382	403	396	410
Indonesia's Rank	57	64	62	72	
Number of Countries	65	65	70	77	

Source*:* OECD Indicators, 2019

The table above shows that Indonesia has a proportion of students with PISA test scores below the minimum level of competence, which is reasonably large for reading, mathematics, and science. The minimum level of competence is an essential indicator for monitoring a country's progress in achieving the target of sustainable development goals (SDGs) 4.1, namely reaching level 2 in the PISA assessment, which shows students can solve problems that require minimum abilities according to international standards and show the characteristics of independent thinking. The average National Examination (UN) scores for SMP/Islamic junior high school MTs/open junior high school SMP Level 2016-2019 also show the same thing, which continues to show a declining trend.

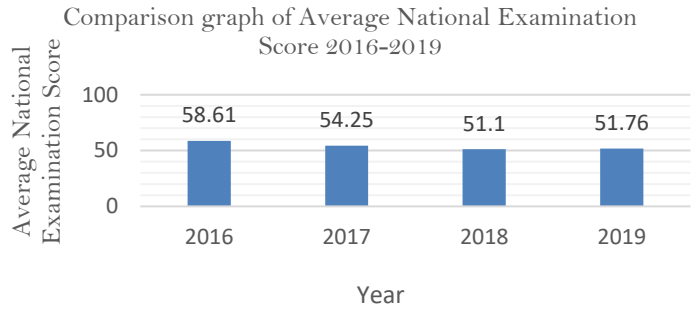

Figure 1. Comparison graph of Average National Examination Score 2016-2019
Source*:* Data on National Examination results, Puspendik, Kemdikbud (accessed 2021)

The low academic achievement of students shows that the quality of human resources is still low. Several factors cause Indonesia's unsatisfactory performance, such as disparities in educational quality based on geographical conditions, socioeconomic conditions of students, and the lack of educational facilities and infrastructure.

Meanwhile, in this digital age, the development of information and communication technology is inseparable from human life. Data from BPS (2018) demonstrated that the use of Information and Communication Technology (ICT) by households in Indonesia had developed rapidly.

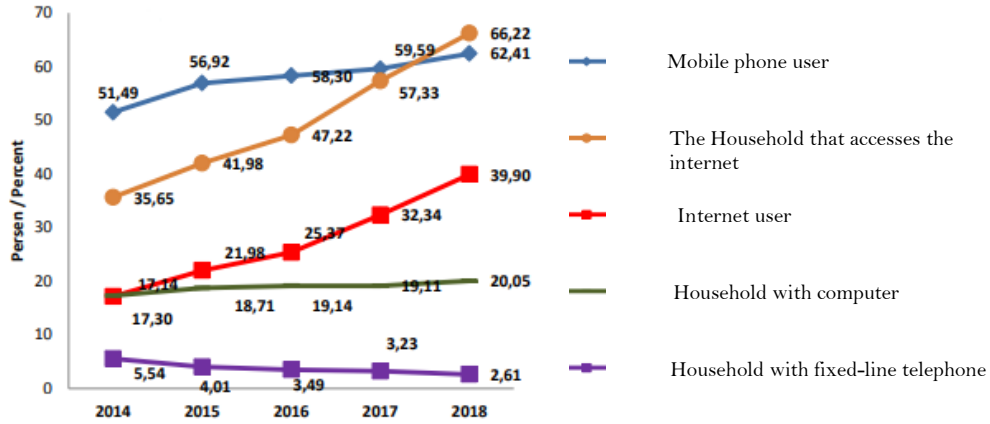

Figure 2. Development of ICT Indicators in Indonesia 2014-2018
Source*:* Indonesian Telecommunications Statistics, BPS (2018)

Furthermore, children who grow up in countries with good ICT development will have more opportunities to adopt new technologies (Ryu, J. 2014). Globalization has yielded a new trend in education, from conventional (in-person) learning to a more open learning system. However, geographical constraints in particular and the availability of devices and access to the internet, including signals and electricity, lead to obstacles and disparities in the learning process for students. Not all children have the same opportunity to implement distance education methods. There are issues with access to and use of technology (R.

Agarwal et al., 2009; Song et al., 2020, Srivastava and Shainesh, 2015). In general, good computer access, fast internet network and good telephone service are only owned by urban communities, while people in rural or underdeveloped areas still have difficulty in obtaining them (Subiakto, H., 2013).

Meanwhile, improving the quality of education is the focus of the government's efforts to boost the achievement of sustainable development goals and targets in the age of Sustainable Development Goals (SDGs) in 2030. Following the target indicators in the SDGs Education framework, the government has set a target to build and improve educational facilities that are child-friendly, as well as provide a safe, non-violent, inclusive, and effective learning environment for all in which the improved school access to (a). Electricity; (b). Internet, and (c). Computers are the basic facilities and infrastructure that schools must possess related to ICT.

Education as a production process can analyze various factors that affect the education output (quantity and quality), including the input of individual students and families (socio-economy of families and socio-demographics of students), school inputs (quality of teachers, facilities, administration, and school curriculum) and other inputs such as geography, the government, and society (Bradley, 2020). In this case, school input is one of the main factors to improve student performance and educational quality. As for the teaching and learning process in schools, facilities and infrastructure are one of the most important parts because they can help the smooth and convenient learning process.

If connected with education from the supply-side perspective, education becomes a discussion from the point of view of education producers, such as educational institutions, and other factors such as intrinsic factors and family conditions. Meanwhile, from the demand side, education is considered a service consumed by students (Glewwe et. Al.,2020). Many policy interventions in education are made not by increasing the demand but by increasing the supply side, where one form of policy taken is to improve the quality of school services.

To date, some previous studies have focused on the supply side that links capital relations in terms of government spending. This study looks at the supply side by applying the theory of education production function that connects education inputs such as school facilities and infrastructure. Concerning ICT, the basic facilities and infrastructure that schools must possess based on the SDGs are computers, access to the internet, and electricity. The following graph describes the development of ICT access in education.

If examined at the basic education level, the proportion of schools with access to computers and the internet for learning is still relatively low compared to secondary and vocational education levels. This finding shows that limitations in terms of the provision of ICT access in schools persist. In this case, the government needs to take steps so that an inclusive education system at all levels of education and learning can achieve the 'education for all' framework (Bernard, 2001).

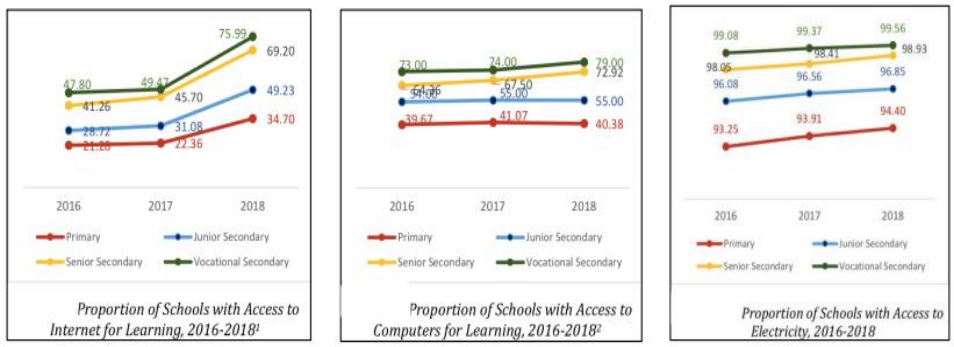

Figure 3. The Proportion of Schools with Access to the Internet, Computers, and Electricity for Learning 2016-2018

Source*:* Voluntary National Reviews, the National Development Planning Agency/Bappenas (2019)

In Indonesia, basic education lasts for nine years, which consists of elementary schools (SD) and junior secondary schools (SMP) for children aged 7 to 15 years old. The graduates of junior secondary schools are approximately the same age as those taking international standard exams such as PISA, which assesses the ability of 15-year-old students at which age is generally students' age completing basic education. Given that the authority for basic education is at the regency/city level, this study will focus on the regency/city level in Indonesia.

Despite several ways to measure educational quality, in general, many previous studies relate ICT inputs to student achievement. In their model, Lee, J.-W. & Barro, R. J. (2001) defines learning outcomes as students' cognitive achievement, which can be measured, among others, by standardized test scores. Indonesia has several assessment systems at the national level, such as the Computer-Based National Examination (UNBK), the National Standardized School Examination (USBN), and the Indonesia National Assessment Program (INAP). At the national level, a comparable measure to compare learning outcomes between regions in Indonesia can be seen from the Indonesia National Assessment Programme (INAP). However, since regency/city level data are unavailable, this study will use the UNBK given its tested integrity. The data used is the UNBK SMP for the 2018/2019 academic year, which has included questions in Mathematics, Literacy, and Sciences that require high order thinking and are of an international standard known as Higher Order Thinking Skills (HOTS). It provides an appropriate proxy for the quality of education.

Nikolopoulou and Gialamas (2016) classify the challenges of using ICT in the learning process from three aspects, namely lack of support, lack of trust (lack of confidence), and lack of equipment. The question of how ICT access can affect the learning performance of the students in Indonesia has not been widely answered yet. Many previous studies have raised this ICT issue at the individual level as well as inter-country level. However, there has been limited studies that specifically relate between ICT facilities and learning performance at district level in Indonesia. Hence, The presumption that schools with access to ICT facilities and infrastructure can affect student learning performance has motivated researchers to fill this gap in the literature. This study will examine how ICT facilities may affect the learning performance of SMP students at district level in Indonesia. It is expected

that the availability of ICT access will positively affect student learning performance. ICT access in this study will focus on the basic facilities and infrastructure that schools must possess based on the SDG framework, namely the availability of computers, access to the internet, and electricity.

The following section will firstly describe the conceptual framework for this research, which consists of Theory of Growth and quality of learning, Education Production Function (EPF), and the role of ICT in education.

1.2. Theoretical Framework

1.2.1. Theory of Growth and Quality of Learning

Education is a way to improve social and economic welfare. According to human capital theory, education maximizes desired lifetime income (Becker, 1975). Capital and labor are the dominant factors influencing economic growth (Solow, 1956). In the neoclassical Solow Swan model, the production function is as follows:

$$Y = F(K, L) \quad (1)$$

Where Y is total output, K is capital, and L is labor/human resources. However, the model was further developed by Appiah & McMahon (2002) by using an endogenous growth model, which shows the general role of education on economic growth, as follows:

$$Y = A\, f(K, H) \quad (2)$$

Where economic growth is influenced by physical capital (K) and human capital (H), and A is the level of technical knowledge. Education is a process of accumulation of human capital. Education can boost a person's work productivity and affect an increase in income. The increase can also affect the country's national income, which then boosts people's standard of living. Meanwhile, failure to build education will cause several issues such as unemployment, crime, and drug abuse, which in the end lead not only to the social aspect but also to the economic burden that various parties will bear, especially the government. The proven relation between educational quality and economic growth is the work of Barro (1997), Hanushek and Kimko (2000), Hanushek, E. and Wößmann L. (2007), Hanushek, E. (2013). The study developed a quality measurement based on cognitive skills in mathematics and science. These are considered to have a strong impact on economic growth. In his research, Barro (1990) found a positive and significant causal relationship between educational quality and economic growth.

Educational outcomes are measured in various ways but can be classified into quality and quantity. Several studies have raised the issue of measuring the educational quality and quantity, such as Lee, J.-W. & Barro, R. J. (1997, 2001), Hanushek (2002, 2003), and Scheerens et al. (2011). Barro (2001) uses test scores as an indicator of educational quality while the ratio of enrollment, attendance, and average length of schooling as an indicator of quantity.

1.2.2. Education Production Functions

Several factors affect student achievement. Hanushek (1979) introduced these factors in the forms of education function theory, where school inputs, student and family

characteristics also affect student performance. Education outputs are directly related to inputs controlled by policymakers (characteristics of schools, teachers, and curriculum) and those not controlled (family and friends, students' intrinsic ability, or student learning capacity). The following equation described the production function:

$$A = a\,(S,Q,C,H,I) \tag{3}$$

Where A is the skills learned/student performance, S is the length of schooling, Q is the quality of schools and teachers, C is the characteristics of children, H is the characteristics of the household, and I is the input of education from the household, such as daily attendance of students and the purchase of textbooks and other school supplies. Thus, it can be assumed that these factors are the school characteristics and socioeconomic characteristics of students' environments.

At the macro level, family factors are defined as socioeconomic factors. Furthermore, Hanushek (2012, 2013) uses PISA test results to measure the quality of education. PISA is the most accepted measure for comparing learning outcomes between countries by looking at the literacy levels of reading, mathematics, and science in the population of 15-year-old schoolchildren in participating countries and comparing their competencies (OECD, 2019).

The government can make policy interventions on the supply and demand sides. Demand-side policies include unconditional and conditional cash transfers, reduced school fees (including non-merit-based scholarships and vouchers), merit-based scholarships, information-based interventions, and other indirect household-based interventions. Supply-side policies include increasing the number of school services offered (building schools, hiring more teachers, and increasing teacher attendance); improving the quality of educational services (providing supplementary materials to students, use of modern information technology, remedial education); other complementary inputs such as nutrition and medical services that can improve student learning (Glewwe, et al., 2020). Many policy interventions in education are made not by increasing the demand but by increasing the supply side.

The Education Production Function (EPF) approach views that educational institutions function as production centers, which if all the required inputs are met, they can produce the desired outputs so that if education inputs such as teacher training, procurement of textbooks and learning tools, and improvements in other educational facilities and infrastructure are fulfilled, quality education will materialize (Hendarman, 2012).

Article 45 of Law of the Republic of Indonesia Number 20 of 2003 on the National Education System regulated the availability of learning media where every academic unit is obliged to provide facilities and infrastructure that meet educational needs following the growth and development of physical potential, intellectual, social, and emotional intelligence, and students' psychology required to support the learning process. Several factors influenced an essential component of the success of education programs through learning, including the availability of adequate educational facilities and infrastructure. Facilities and infrastructure are of particular importance in supporting smooth and convenient learning. Under SDG4, educational facilities that schools must possess to support the quality of teaching and learning include access to electricity, the internet, and computers

for education, infrastructure, and materials that have been adapted for students with disabilities, drinking water, sanitation facilities for each gender. and handwashing facilities. With its relation to ICT, the input that becomes the topic of discussion in this research is ICT facilities and infrastructure based on SDG4, namely the availability of computers, access to the internet, and electricity. ICT resources can be added to standard models of education production (Hanushek 1979, 1986; Rivkin, Hanushek, and Kain 2005; Todd and Wolpin 2003). ICT-based educational facilities and infrastructure are all objects required to support teaching and learning activities, both directly and indirectly that use information processing and delivery systems by applying computer technology required to implement the educational process. (Siahaan, 2010). If schools provide access to ICT facilities and infrastructure, the quality of education will improve, and productivity will increase (Bariu, T. N., 2020).

1.2.3. The Role of ICT in Education

Research by Aziz et al. (2010) explains that significant developments in information technology have a significant impact on the role of academic units. Academic units are vying to invest in ICT tools. Regardless of how vital ICT in education is, the use of ICT in a country depends on the accessibility of ICT and the extent to which its population is "competent" or "familiar" with ICT itself. In developing countries, not only do poor households lack access to ICT at home, but students from these countries may also have limited access to ICT even at school. Besides, many schools still lack ICT infrastructure and other resources due to budget constraints. It is likely that they also lack ICT teachers.

Becta (2002) and Machin et al. (2007) found a positive and significant correlation between the availability of computers in schools and student achievement. Becta (2002) suggested a significant positive relationship between ICT and student achievement in several subjects. Machin et al. (2007) also evaluated whether changes in ICT investment had a causal impact on educational outcomes in English schools between 1999 and 2003. Using the Instrumental Variable (IV) approach to control for the endogeneity of ICT use, the results showed a positive causal impact of ICT investment on educational performance in elementary schools.

Furthermore, several empirical studies have found that students who have computer facilities or the internet at home score better on the PISA test or the national standardized test (Becta, 2002; Spiezia, 2011; Delen & Bulut, 2011; Castro Aristizabal et al., 2012; Anil & Ozer, 2012; Ryu, 2014; Erdogdu, 2015; Botello & Guerrero, 2015).

Several studies show that the use of ICT has no effect or even has a negative effect on student performance. Fuchs and Woessmann (2004) suggested that the availability and use of computers at school and home do not have a significant relationship with the PISA; Wittwer, J. and Martin Senkbeil (2008) show that computers do not have a significant influence on academic achievement of most students and even research by Sprietsma (2011), and Bauermann et al. (2013) shows a negative effect on educational outcomes. In Peru, a study by Bauermann et al. (2013) found that students who have computers at home have lower academic achievement because they spend more time assisting with household chores than doing schoolwork. After all, parents use computers as a present to encourage their

children to help with household chores. In short, students' family backgrounds influence the impact of ICT on students' academic achievement.

Reviewing the literature above, previous research has concentrated on student/individual-level student data rather than country level. Few studies concentrate on a macroeconomic approach. The macroeconomic approach will provide new insights to find generalizable results for policy design. Therefore, this study uses a macroeconomic model with data from various regencies/cities in Indonesia to find a correlation between ICT access and educational quality and to examine its effect on learning performance in developing countries, such as Indonesia.

II. Methodology

The data for this study come from the Ministry of Education and Culture (Kemendikbud) and Statistics Indonesia (BPS), both through written requests and data on the official website. The data for the dependent variable (average UNBK SMP for the 2018/2019 academic year), independent variables, and other control variables in this study used 2018 data. The sample used is 485 out of 514 regencies/cities because several regencies/cities have not implemented UNBK. DKI Jakarta province was not included in the sample, considering that the authority for elementary and secondary education lies at the regency/city government, not the provincial government. Due to data limitations, the analysis in this study uses a quantitative approach with cross-sectional data analysis per regency/city in Indonesia using the Ordinary Least Square (OLS) method.

The research variables used in this study are based on the theory of education production. This theory uses an individual approach. However, since this study uses a macroeconomic model with data from various regencies/cities in Indonesia, there is individual information that may be lost because of the aggregation to the regency/city level. Furthermore, this study applies the research model of Lee & Barro (2001), which extends the analysis of Hanushek & Kimko (2000) to analyze the determinants of school quality in many countries. They use the education production function, which relates the education outputs to their inputs at the macro level. In particular, the impact of ICT access on learning outcome has also been applied at the country level by Ryu, J. (2014) with the following model:

$$Qit = \alpha 0 + ICTit*\beta 1 + Fit*\beta 2 + Rit*\beta 3 + Cit*\beta 4 + \varepsilon it \quad (4)$$

Where Qit denotes educational outcomes in each country i in year t, ICTi is the variable indicating the ICT factor in country i, Fi denotes the influence of family factors in country i, Ri denotes the school resource factor for country i, and Ci denotes other control variables that can be related to educational outcomes for country i in year t, and εi denotes an unmeasured factor.

Furthermore, the regression analysis used in this study was similar to that of Barro & Lee (2001), Gupta, Verhoeven & Tiongson (2002), and Rajkumar & Swaroop (2008) with some adjustments due to the availability of data at the regency/city level in Indonesia. In their model, Lee & Barro (2001) defines learning outcomes as students' cognitive

achievement, which can be measured, among other things, by standardized test scores. At the international level, many researchers have previously used PISA data as a standardized test to measure the quality of education.

To obtain a proxy that meets international standard tests in a regional scope, the dependent variable used in this study is the data on the national examination scores, namely the Computer-Based National Examination (UNBK) given its tested integrity and the UNBK for the 2018/2019 Academic Year used in this study has started to adopt the PISA standard using "high order thinking skills (HOTS)" in the questions. In addition, in its implementation, it also uses ICT facilities as a medium for the test. However, since the proportion of schools that implement UNBK is not evenly distributed in each regency/city, the dependent variable can result in bias.

The ICT variables used in this study focus on ICT facilities and infrastructure in schools according to SDG4, where ICT facilities and infrastructure in schools are input to educational outcomes. The indicator of the proportion of households owning a computer and using the internet was chosen because it demonstrates the use of ICT in student's houses in an area (Ryu J., 2014). Meanwhile, the magnitude of student-to-teacher ratio per regency/city in Indonesia shows school characteristic factors (Altinok 2007; Samarrai et al., 2013), as well as the ratio of student classroom conditions (Mahdalena, 2019), where non-ideal conditions in schools can affect student learning outcomes. On regional socioeconomic characteristics, this study uses the poverty ratio variable to reflect the level of welfare in the regency/city, which indicates the capacity of households to invest in education. This variable is used in the study rather than income per capita because previous studies conducted by Gupta, Verhoeven & Tiongson (2002), and Rajkumar & Swaroop (2008) found a significant relationship between poverty and educational outcomes.

Furthermore, the population density variable is also used in this study to examine the population's access to school resources. The high rate of population growth generally stems from the rapid growth of the younger generation in need of education (Bloom et al., 2004). The population density in this study is calculated by dividing the total population (people) by the area in each regency/city. More and more people with a small area illustrate that there has been a population density in that area where the ideal socioeconomic conditions of students will affect student learning outcomes.

Other factors used as control variables in this study are location and regional ICT infrastructure. The electricity ratio variable used in this study aims to capture the percentage of households electrified in an area where the availability of electricity has a significant impact on the growth of the telecommunications industry (Wibowo et al., 2018). The regional location variable is also included in the estimation model to capture differences in student achievement between the conditions of the population living in urban and rural areas in a regency/city. Sakaue, K. 2014; Jasmina, 2016 found that the more households that live in urban areas, the better the student achievement will be because the households have better infrastructure. Base Transceiver Station (BTS) is the leading infrastructure element connecting customer devices to the network. The ICT infrastructure factor, in this case, uses the BTS availability variable in an area. So there is a modification of equation (3.1) of the previous model, which is stated in equation (3.2), where i denotes regency/city:

$$un\_g_i = \alpha_i + rasio\_komp\_sk1_i * \beta_1 + rasio\_internet\_sk_i * \beta_2 + rasio\_listrik\_sk_i * \beta_3 + rasio\_komp\_rt_i * \beta_4 + rasio\_internet\_rt_i * \beta_5 + kelas\_g_i * \beta_6 + str\_g_i * \beta_7 + poverty_i * \beta_8 + pop\_dens_i * \beta_9 + electrification\_ratio_i * \beta_{10} + BTS_i * \beta_{11} + dummy\_timur * \beta_{12} + \epsilon_i \quad (5)$$

The dependent variable is the National Examination, which is the average number of UNBK SMP students (scale 0-100) in the regency/city i. The primary independent variable is the percentage of schools that have school ICT facilities and infrastructure according to SDG4, such as the availability of computers, access to the internet, and electricity in schools. The independent control variable for household characteristics, namely the percentage of households that have children with SMP education level who have computers and use the internet, is obtained from BPS' Susenas data. The characteristics of the school are STR, which is the student-to-SMP teacher ratio. Class is the percentage of schools that have good classroom conditions and minor damage. The data on the socioeconomic control variables of regencies/cities are obtained from BPS, including poverty or the percentage of poor people, population density, or the number of residents per area (person/Km2). The characteristics of the location and regional infrastructure include the electrification ratio or the percentage of the area that is electrified (%), and the number of available BTS in an area (units). Lastly, to find out the difference in National Examination scores between eastern Indonesia and other regions, the eastern dummy variable is used where number 1 indicates regencies/cities in eastern Indonesia (regions with the Eastern Indonesian Time (WIT) system, such as regencies/cities in the provinces of Maluku, North Maluku, Papua, and West Papua). Number 0 indicates other regencies/cities and e_i is the residual/error term in the regression. The following discussion will elaborate on the selection of the regression model above.

III. Results, Analysis, and Discussions

The descriptive statistics of the research variables are shown in Table 2 below, which shows the total sample of 485 regency/cities in Indonesia for the year of 2018:

Table 2. Research Data Descriptive Statistics

Variable	Obs*	Mean	Std. Dev	Min	Max
un_g	485	50,14	6,09	36,31	72,48
ratio_computer_sk (%)	485	81,24	12,78	21,43	100
ratio_internet_sk (%)	485	76,57	19,54	4,76	100
ratio_electricity_sk (%)	485	96,05	7,21	33,33	100
ratio_computer_rt(%)	485	34,19	21,02	0	100
ratio_internet_rt(%)	485	56,1	22,65	0	99,51
class_g (%)	485	80,93	10,42	36,17	100
str_g (%)	485	13,11	3,27	5,39	24,23
poverty (%)	485	11,52	6,48	1,68	39,22
pop_dens(persons/km2)	485	984,34	2221,85	0,78	15426,05
share_urban(%)	485	41,38	30,46	0	100
electrification_ratio(%)	485	94,97	13,07	0	100
BTS(unit)	485	65,02	52,02	3	333

*** The number of observations in this study was 485 regencies/cities for one-year data.**

Source*:* data processed by the author

Based on Table 2, the average UNBK SMP from this research sample was 50.14, with the lowest score of 36.31 and the highest score of 72.48. The UNBK is a system of national examination implementation using a computer as the test medium. The implementation of the UNBK has started in stages since 2014. There were 7,507,116 or 90.9% of participants who took part in the UNBK from a total of 8,259,581 National Examination participants (Kemdikbud, 2019). However, not all schools can carry out the UNBK because the schools must meet several facility requirements and certain specifications in the implementation, including having a computer laboratory officer, computer facilities with certain specifications, an internet network with a minimum bandwidth of 1 Mbps, and a local area network (LAN) with certain specifications. The UNBK implementation still uses a semi-online system. Schools with at least one server and more than 20 units of computer devices can be designated as the place for the UNBK implementation. Schools that do not meet the requirements but want to implement UNBK can use facilities from other schools. On average, the results of the 2018 UNBK SMP are still in the deficient category[1].

The average ratio of schools with computers per regency/city is 81.24%, with the lowest ratio per regency/city of 21.43% of schools in Aru Islands and at most have computers as much as 100% of schools. This result is an average based on the availability of devices only, not the number of units available. As for access to the internet in schools per regency/city, it has an average of 76.57% schools with at least 4.76% schools in Pegunungan Bintang Regency and at most 100% schools in a regency/city. In addition, the ratio of schools with access to electricity per regency/city has an average of 95.95% schools with at least 33.33% and at most 100% schools. In each regency/city, the average computer ownership in households with children at the SMP level is 34.19%, with the lowest ratio being 0% in Membramo Raya. Next, the average number of households using internet access is 56.1%, with the highest ratio of 99.51% in Yogyakarta city and the lowest at 0% in the regencies of Tambrauw and Membramo Raya.

On the variable of student-to-teacher ratio per regency/city in Indonesia, on average, one teacher teaches 13 SMP students. This ratio is lower than the international average of 23 (World Bank, 2020). Moreover, the average proportion of classes with good classroom conditions and minor damage is 80.93%. This finding indicates that most classrooms are in good condition in all regencies/cities.

On the socioeconomic control variable, the average percentage of poverty in Indonesia is 11.52%. The city with the lowest poverty is South Tangerang with a percentage of 1.68%, and the highest is 39.22% in Supiori Regency. The average population density in a regency/city is 984 people/km2, with the most densely populated area being Cimahi city with a population density of 15,261 people/km2. On average, the proportion of urban areas in Indonesia is still low at 41.38%. The figure shows that most areas in Indonesia in 2018 were rural areas. Meanwhile, on average, 94.97% of areas in Indonesia are electrified, where the area with the least electricity is 0%, namely the Tanah Laut area. Next, the average

[1] Based on the Standard Operating Procedures for the 2018 National Examination, the UNBK score is categorized as deficient for scores lower than or equal to 55; average for higher than 55 and lower than or equal to 70; good for higher than 70 and lower than or equal to 85, and very good for higher than 85 and lower than or equal to 100.

number of BTS availability in Indonesia is 65 units, where Waropen Regency has the least BTS availability with three units.

Table 3. Estimation Results

VARIABLES	(1) Regression 1	(2) Regression 2	(3) Regression 3	(4) Regression 4
rasio_computer_sk1	**0.0906*** **	**0.0911*** **	**0.0909*** **	**0.0914*** **
	(0.0236)	(0.0232)	(0.0235)	(0.0232)
rasio_internet_sk	0.0150	0.00385	0.0132	0.00542
	(0.0175)	(0.0176)	(0.0170)	(0.0169)
rasio_electricity_sk	-0.0425	-0.0475	-0.0374	-0.0412
	(0.0398)	(0.0381)	(0.0382)	(0.0371)
rasio_computer_rt	**0.0743*** **	**0.0739*** **	**0.0692*** **	**0.0702*** **
	(0.0156)	(0.0157)	(0.0152)	(0.0153)
rasio_internet_rt	**0.0282** **	**0.0255** *	**0.0295** **	**0.0280** **
	(0.0143)	(0.0142)	(0.0137)	(0.0137)
class_g	**0.0622*** **	**0.0649*** **	**0.0583*** **	**0.0619*** **
	(0.0239)	(0.0236)	(0.0223)	(0.0221)
str_g	**0.242*** **	**0.260*** **	**0.186** **	**0.213*** **
	(0.0795)	(0.0791)	(0.0755)	(0.0762)
poverty	**-0.0617** *	-0.0333	**-0.0612** *	-0.0405
	(0.0367)	(0.0375)	(0.0358)	(0.0361)
share_urban	**0.0215** **	**0.0258** **		
	(0.0103)	(0.0104)		
pop_dens			**0.000554*** **	**0.000548*** **
			(0.000122)	(0.000121)
electrification_ratio	0.0148	0.0138	0.0120	0.0115
	(0.0103)	(0.00995)	(0.0106)	(0.0104)
Bts	-0.00438	-0.00542	-0.00224	-0.00363
	(0.00480)	(0.00479)	(0.00464)	(0.00467)
dummy_east		**-2.140*** **		**-1.686** **
		(0.766)		(0.679)
Constant	***32.08*** **	***32.94*** **	***33.33*** **	***33.71*** **
	(3.956)	(3.741)	(3.749)	(3.583)
Observations	485	485	485	485
R-squared	0.543	0.550	0.566	0.571

Robust standard errors in parentheses

*** p<0.01,**p<0.05,*p<0.1

Source*:* data processed by the author

Table 3 presented the estimation results of the regression model (3.2) above, with four combinations of regression models. The first regression (1) uses the primary independent variable with control for household characteristics, schools, and socioeconomic characteristics (poverty) as well as regional location characteristics (Share Urban, electrification ratio, and BTS availability). The second regression (2) adds an eastern dummy variable to examine the difference in the National Examination scores in eastern Indonesia. In the third regression (3), population density (pop_dens) in the estimation replaced the share_urban variable to examine the consistency of the results on other variables. This variable is used to examine the effect of population density within a regency/city since this will reflect access to school resources. The regression results show a bigger change in the R-squared value and a higher level of significance (1 percent) compared to using the share_urban variable in regressions 1 and 2 (5 percent). Then, in the fourth regression (4), a dummy variable is added for the eastern region to examine the difference in the National Examination scores in eastern Indonesia. The regression results show that the National Examination scores in eastern Indonesia are significantly lower than those in other regions.

The above estimation results have been through a series of formal tests. Considering a heteroscedasticity issue in the model, it is done robustly to overcome it. The selection of control variables in this study also considers the issue of multicollinearity between independent variables. From the various estimation models, including the relevant control variables (household, school, and regional socioeconomic characteristics) and looking at the consistent regression results for the ICT variable from all regressions, as well as the higher R-squared value, the analysis used the results in the fourth regression.

The fourth regression shows that the variable of the ratio of the availability of school computers has a significant positive relation to the educational achievement of SMP students, where an increase in the proportion of schools with computers in regencies/cities by one percent can increase the UNBK scores by 0.09 points. These results are consistent with the four regressions in Table 3 above. The finding is consistent with the research hypothesis where the availability of ICT facilities can have a positive impact on the learning outcomes of SMP students in Indonesia. The proportion of households with computers also has a significant impact on the National Examination scores. An increase in the proportion of schools with computers in regencies/cities by one percent can increase the UNBK scores by 0.07 points. The increase happens because the computer is one of the most needed facilities and infrastructure for students, especially at the junior high school level since it can be used as a learning medium (Center for Policy Research, the Ministry of Education and Culture, 2020). The increase is consistent with previous research (Becta, 2002; Ishaq et al., 2020), where students who have computer facilities both at home and school will attain better grades on student achievement. If examined from descriptive data, the average proportion of schools with computers in regencies/cities in Indonesia is 80%. However, this study cannot capture how many computers are available in schools. The more schools with a minimum of 20 computers, the more schools can implement UNBK. The government's efforts are required to increase the number of computers available in schools because it will improve the learning performance of students.

Furthermore, the proportion of schools with access to the internet in schools is not significant to the UNBK results for SMP students. The results of this study are not

consistent with the research hypothesis. The result is presumably because the use of the internet in schools has not been optimal to improve the learning performance, although the 2013 curriculum has mandated that the learning is held based on various learning resources. Many teachers still encounter challenges in integrating ICT tools in learning activities (Nikolopoulou and Gialamas, 2016). In this case, many schools in remote locations with geographical constraints have limited access to supporting infrastructures, such as electricity supply and internet networks (Ministry of Education and Culture's Performance Report, 2019).

The same results also happened to the variable ratio of the availability of access to school electricity. The regression shows that the proportion of schools with access to electricity has no effect on UNBK results for SMP students. This result is also not consistent with the research hypothesis. The result is presumably because electricity access in schools is not only used for the learning process. On average, the ratio of access to school electricity is relatively high, namely 95.95%. However, most of the lowest access ratios to school electricity are in regencies/cities in Eastern Indonesia. The descriptive data showed that from the average ratio of access to school electricity of 95.95%, Pegunungan Bintang Regency only has access to electricity of 33%. As a basic infrastructure to support other ICT devices, efforts to increase access to electricity must continue to be pursued (Swarts & Wachira, 2009).

The difference in the effect existed between the availability of ICT access in schools and ICT access in households. The proportion of households with computers and access to the internet has a positive and significant impact on the National Examination score. The use of ICT access at home showed positive results in improving student learning outcomes. An increase in the proportion of households with access to computers at home by one percent can increase the National Examination score by 0.07 points, and an increase in the proportion of households with access to the internet at home by one percent can increase the National Examination score by 0.028 points. This result is consistent with the research hypothesis where ICT access has a positive effect on learning performance. This result is also consistent with research (Becta, 2002; Spiezia, 2011; Delen & Bulut, 2011; Castro Aristizabal et al., 2012; Anil & Ozer, 2012; Ryu, 2014; Erdogdu, 2015; Botello & Guerrero, 2015) which shows that students who have computers or access to the internet at home, their scores on the PISA Program or national standardized tests can improve. This research data (Table 2) showed that the average proportion of households with computers is still low, namely 34%, and those with access to the internet are only 56%. Therefore, an increase in the number of households with ICT facilities at home is required to support the learning performance of students.

As for other independent control variables used, it shows that the independent control variables of school characteristics, namely the size of the student-to-teacher ratio and the ratio of class conditions, also have a significant positive effect on learning performance. An increase of one teacher per student can increase the National Examination score by 0.21 points. The result is not consistent with a research by Barro (2001), where an increase in the student-to-teacher ratio will decrease student learning outcomes. The research data showed the average student-to-teacher ratio at the SMP level is 13.07, lower than the ideal standard of student-to-teacher ratio for elementary and junior secondary education set by the government at 20 (Government Regulation Number 74 of 2008 on Teachers) and the

International average ratio at 25 (World Bank 2017). A lower student-to-teacher ratio indicates an oversupply of teachers and an uneven distribution of teachers across regions at the regency level in Indonesia.

The regression results on classroom conditions show a significant positive relationship, where a one percent increase in the proportion of schools with good classroom conditions and minor damage can increase the National Examination score by 0.06 points. The research data showed that the average class with good conditions and minor damage in SMP in Indonesia is 80.97%. There are still around 19.03% of classes needing repair due to moderate/severe/total damaged conditions. The result is consistent with a research by Mahdalena (2019), where non-ideal classroom conditions in schools can affect student learning outcomes.

On socioeconomic characteristics, the independent control variable of socioeconomic characteristics shows that the poverty ratio variable does not have a significant influence on the learning outcomes of SMP students. This result can happen because the UNBK score is the average score per regency/city from individual student results, so there is a possibility that the poverty ratio does not directly affect individual performance. However, the population density variable shows a significantly positive result on the learning performance of SMP students with a significance level of one percent. These results indicate that an increase in the population density of one person per km2 can increase the UNBK scores by 0.001 points. The result shows that the more people living in densely populated areas generally indicate that they live in urban areas, where ICT facilities and infrastructure will be better, and technology will be more accessible to improve the learning performance of students.

Furthermore, the results of all regressions on the control variables of location characteristics (BTS availability and the proportion of electrified areas) show insignificant results on the learning performance of SMP students. This result can happen because the UNBK results are the average scores per regency/city from individual student results, so there is a possibility that the BTS availability and the proportion of electrified areas do not directly affect individual performance. In addition, the UNBK implementation in 2018 took place semi-online and sharing resources, where the UNBK can still be implemented by sharing facilities with other schools.

To gain an in-depth understanding of the differences in the influence of the eastern region of Indonesia on the dependent variable, the authors add a dummy variable to the eastern region in the fourth regression (see Table 3). The results of the fourth regression show that the UNBK scores in the eastern region tend to be lower than those of other regions. The statistics on the scores between regions in the UNBK SMP for the 2018/2019 academic year based on the Performance Criteria in the 2018 Standard Operating Procedures, are as follows:

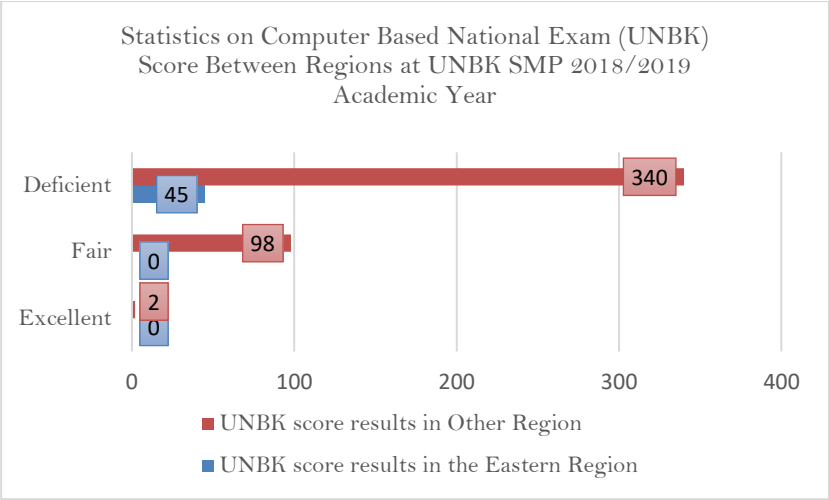

Figure 4. Statistics on Scores Between Regions at UNBK SMP for 2018/2019 Academic Year

Source*:* Data processed by the authors

All regencies/cities in the eastern region attained a "deficient" score category in the UNBK for the 2018/2019 academic year. The result can happen because of many schools in the eastern region, including the 3T (disadvantaged, frontier, and outermost) regions in Indonesia. The 2018 Ministry of Education and Culture's Performance Report (2019) showed that overall the eastern region has a lower percentage of UNBK implementation than other regions. With geographical constraints, the eastern region has limited access to supporting infrastructures, such as electricity supply and an internet network to implement UNBK. The result is consistent with the research hypothesis that the availability of access to the internet can improve the learning performance of SMP students.

IV. Conclusion and Recommendation

Using the Ordinary Least Square (OLS) method in cross-sectional data from regencies/cities in Indonesia in 2018, the results of this study indicate that the availability of computers in schools significantly and positively affects the educational performance of SMP students. This result can happen because the computer is one of the facilities and infrastructure that students need, especially at the SMP level. After all, it serves as a learning medium. In addition, computer facilities are an essential tool in the UNBK implementation because it is one of the requirements to implement UNBK. The more schools with a minimum of 20 computers, the more schools can implement UNBK. The availability of access to electricity and the internet in schools has no impact on improving student learning performance. This result is presumably because the use of the internet and electricity in schools has not been optimal to improve learning performance, although the 2013 curriculum has mandated that the learning is held based on various learning resources.

Furthermore, the availability of computers and access to the internet in households has a positive effect on improving student learning performance. These results are consistent

with the research hypothesis, where ICT access can have a positive effect on the learning performance of SMP students in Indonesia. On average, less than 60% of students have computers and internet access at home.

On the school characteristics, it shows that the variable of student-to-teacher ratio and the class condition ratio also has a significant positive effect on learning performance. The research data showed that the average student-to-teacher ratio at the SMP level is still lower than the ideal standard of student-to-teacher ratio for elementary and junior secondary education set by the government at 20 (Government Regulation Number 74 of 2008 on Teachers) and the International average ratio at 25 (World Bank 2017). In this study, on average, there are still around 19.03% of classes needing repair due to moderate/severe/total damaged conditions.

On socioeconomic characteristics, the variable of poverty ratio does not have a significant influence on the learning outcomes of SMP students. This result can happen because the UNBK score is the average score per regency/city of individual student results, so there is a possibility that the poverty ratio does not directly affect individual performance. In addition, the population density variable shows a significantly positive result on the learning performance of SMP students with a significance level of one %. This result shows that more people who live in densely populated areas indicate that more people live in urban areas, where infrastructure will be better, and technology will be more accessible.

Next, the results of all regressions on the control variables of location characteristics (BTS availability and the proportion of electrified areas) consistently show insignificant results on the learning performance of SMP students. This result can happen because the UNBK results are the average scores per regency/city of individual student results, so there is a possibility that the BTS availability and the proportion of electrified areas do not directly affect individual performance. Finally, the regression results also show that the UNBK scores of eastern regions tend to be lower than those of other regions. With geographical constraints, the eastern region has limited access to supporting infrastructures, such as electricity supply and an internet network.

As an essential means for student learning media, in this case, the government's efforts are required to increase the number of computers available in schools because it can affect the learning performance of students. Furthermore, the results of this study indicate that the UNBK scores in eastern Indonesia are lower than those of other regions. This study also revealed that the results on the variables of school characteristics, the student-to-teacher ratio, and class conditions also showed significant results in improving the learning outcomes of SMP students.

Hence, the government needs to focus on improvement and equity of ICT resources in schools, especially in eastern Indonesia. This study shows that the government's efforts are required to increase the student-to-teacher ratio with an even distribution of teachers and continue to make improvements/renovations to damaged school classes.

This study has a research limitation where the type of data used in this study is cross-sectional data so that the results obtained only reflect the conditions of the year concerned. If data is available, further research using the cross-section and time series data aims to provide better results. Furthermore, since the UNBK is abolished starting in the 2019/2020

academic year (under Circular of Minister of Education and Culture Number 4 of 2020 on the Implementation of Educational Policies amid the Emergency Period of the Spread of Coronavirus Disease), a further study that will examine the impact on learning performance is recommended to use AKSI/INAP data as a proxy that is in accordance more with PISA. This study shows results that reflect the overall average score of UNBK per regency/city. Therefore, to obtain a more in-depth analysis, further study may also be able to analyze its effect on the score per subject of the National Examination or also its effect on sub-regions in Indonesia to obtain more complete results.

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