Global and Systemic Perspectives on Mathematics and Science Performance of ASEAN Member Countries

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Abstract

The study aimed to determine the extent of student–teacher ratio's influence on the science and mathematics performance of students in Southeast Asian countries. It also determines how much national productivity in terms of GNI per capita is needed to support the optimal class sizes of these countries. A descriptive–correlation design, particularly the linear regression analysis, was used during the analysis of data, which were taken from the data banks of the UNESCO and World Data Bank (2017). Results of the study reveal that there was a negative high correlation between the student–teacher ratio and the mathematics and science index of the students among ASEAN countries. Moreover, a positive high correlation between student–teacher ratio and the GNI per capita of a country was observed from the findings. These results describe that ASEAN countries having higher GNI per capita have lower student–teacher ratios. This implies that budget is essential to reduce classroom sizes, which impacts students' performances in mathematics and science. From this, a model was generated to determine how much budget is needed for each of these countries to support the optimal class sizes. The optimal class size was patterned after the leading ASEAN countries, which is 12 students to a teacher.

Keywords:Class size, student-teacher ratio, GNI per capita, budget, mathematics and science index, ASEAN countries

1. Introduction

Advancement in human civilization is, to a large extent, contingent upon developments in Mathematics and Science. It is, therefore, not surprising to find that both subjects are required in the formation of primary schooling among students all over the world. Learning Mathematics and Science, however, requires greater concentration and dedication to master these disciplines, unlike other courses in primary school where a larger number of students would be beneficial to master socialization skills. It is, thus, posited that Mathematics and Science are best learned when the number of students assigned to a teacher is smaller as compared to non-science courses. Concomitant to this global issue are systemic issues occurring in different countries across the globe. Smaller class sizes imply greater financial resources. The financial resources, in turn, are dependent upon the countries' labor force productivity, resulting in trade surpluses.

Mathematics is taught in school because it helps the individual perform the essential tasks needed for an individual to become a productive adult (Karp et al., 2017). For instance, trigonometry is used by navigators in maneuvering ships, while statistics is used by teachers to become efficient in reporting the grades and performances of their students. Furthermore, students are expected to leave school having mastered the skills in mathematics that will help them fulfill their potential (Gurney, 2016). If children get to achieve the minimum mathematics skills needed in the lower grades, then it would be much easier for them to achieve the skills needed in the higher years (Ward, 2018).

Success in mathematics is highly associated with opportunities and riches, which gives an individual a chance to get paid better when he/she holds a better performance in mathematics (Gates, 2002).

Indeed, Gurney (2016) indicated that employers highly valued mathematics, which is linked to their employees' higher earnings. Also, Ward (2018) pointed out that students' mathematics proficiency is directly related to a country's income, especially the most developed countries that are members of the OECD (Organization for Economic Co-operation and Development).

However, fewer are learning mathematics, especially in middle- to low-income countries around the globe. Indeed, only 20% of children in these countries achieve the minimum proficiency in mathematics; level 2 for the middle-income countries and level 1 for the low-income countries. This data is opposite to the percentage of children in OECD countries, countries with higher income, wherein 80% of their children had achieved their minimum proficiency in the subject, including the fact that the average achievement of these countries in mathematics is at level 3 and 4 (Ward, 2018).

The information above discloses a disparity in mathematics performance between the higher income countries and mid to low-income countries. At this point, the researcher wishes to quantify the impact of class sizes on mathematics and science performance and, thereafter, determine the national productivity (GNI per capita) required to support such optimal class sizes among ASEAN countries.

The framework of this study is anchored on Pritchard's theory of class size reduction as it affects the academic achievement of the students. Pritchard (1999) theorized that children perform better in class when student–teacher ratio is reduced as it results in a positive environment due to the development of better relationships among students, teachers, and parents (Uhrain, 2016). It was emphasized that students received more individualized assistance from teachers when classes were smaller. Uhrain (2016) explicitly pointed out that academic and behavioral problems among students are minimized through the mechanism of smaller class sizes. This indeed increases students learning and promotes higher academic achievement (Krasnoff,2014; Hirschfeld, 2016) as well as decreases students' classroom behavior issues (Hirschfeld, 2016).

Moreover, investment in class size reduction is notably preferred to be spent by more than half of the citizens rather than increasing the salary of their teachers (Krasnoff, 2016). With this, the government would rather like to invest in hiring more teachers in order to cater to the educational needs of their students than promoting and increasing their teachers' salaries. This requires more financial assistance and budgetary support for education in order to invest in the long-term productivity of the country.

The conceptual framework of the study shown below illustrates the relationship of the two independent factors, GNI per capita and student–teacher ratio, to the mathematics and science

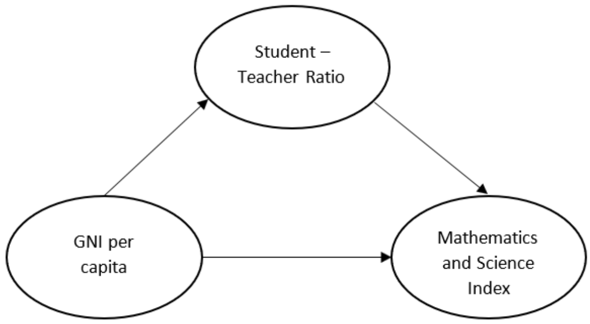

Fig.1. The Schematic Diagram of the Study

performance indices of the ASEAN countries. Explicitly, the framework explains the extent of influence of the student–teacher ratio to the dependent variable with the end view of coming up with a suggested national productivity in terms of GNI per capita for each student to support the optimal classroom sizes designed to increase student's mathematics and science achievement. This suggestion is believed to be of importance specifically to the low-income countries in Southeast Asia for them to focus on investing in education and eventually increase national productivity in the time being.

2. Objectives

This study attempted to examine how much the GNI per capita, student-teacher ratio, and mathematics and science index related to one another. Specifically, it aimed to investigate the extent of influence of the student–teacher ratio to mathematics and science performances of the students. Moreover, this aimed to suggest a needed national productivity in terms of GNI per capita to support the optimal class sizes, especially those low-income countries having larger class sizes.

3. Methodology

A descriptive-correlation research design is used in this study. Specifically, it uses regression analysis, with the help of software, to examine if the independent variable is successful in predicting the outcome variable and whether the independent variable is a significant predictor of the result. In this study, the linear regression with two independent factors, namely the class size and the national productivity in terms of GNI per capita, will be built and set as relevant factors that affect the mathematics and science performance of the students in the ASEAN countries.

For this study, the mathematics and science performances of the students, as well as the student–teacher ratio and GNI per capita, will be examined and taken from the Our World in Data and the UNESCO's Institute for Statistics dated 2017. Data mining was used to locate previously unknown but interesting and useful patterns and relationships within the identified variables retrieved from the large amount of data available in the mentioned data banks. After extracting usable data from the larger set of raw data, one of the limitations of this study is the narrowed eight ASEAN countries. These are Singapore, Malaysia, Philippines, Indonesia, Brunei Darussalam, Thailand, Vietnam, and Cambodia. This means that the study abides data transparency, extracting only the usable data from the large data set narrowing to the eight mentioned ASEAN countries. Besides, no alteration of the data was made from the originalset.

4. Results and Discussions

The figure below shows the Mathematics and Science index of the Southeast Asian countries analyzed against their country's student–teacher ratio. The plot is evident that the countries having less student-teacher ratio tend to have higher index in mathematics and science. Among these countries are Singapore, Malaysia, Brunei Darussalam, and Indonesia. Whereas, ASEAN countries having greater student-teacher ratio tend to have less index in the said areas. This includes the Philippines, Thailand, Vietnam, and Cambodia. This illustration initially supports the assumption that the larger the class size is, the smaller the chance students can perform well in mathematics as well as in science.

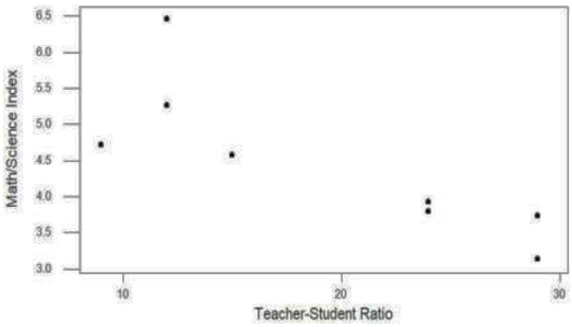

Figure 2. *Mathematics and Science Index and the Student_Teacher Ratio*

This result is evident in the calculated negative high correlation value (r = –0.82; p = 0.013) between the variables. This means that the larger the mathematics and science performances of the students are, the smaller the student–teacher ratio in a certain country will be. This assumption was further analyzed using the regression model analysis. The regression model below gives the equation

Math and Science index = 6.49 - 0.106 Student-Teacher Ratio,

estimates how much class size predicts the mathematics performance of the students. With this, the result obtains an R^2 value of 67.4% for the student–teacher ratio. This means that 67.4% of the mathematics and science performance of the students are influenced and can be explained by the student – teacher ratio or class size. This means that small group learning helps improve the mathematics performance of the students (Enu et al., 2015) and that having large classes tends to have very low performances in the said area (Yara, 2010).

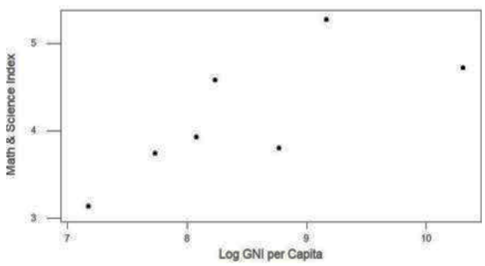

Figure 3. *Mathematics and Science Index and Gross National Income per Capita*

Moreover, when the Math and Science index and GNI per capita were plotted and analyzed, the figure above evidently shows a positive linear trend of these variables among the ASEAN countries. This is verified in the obtained high positive correlation (r = 0.74; p = 0.05) between the mathematics and science index and gross national income (GNI) per capita. This means that the higher the mathematics index of the country is, the higher its GNI per capita will be. Moreover, based on the regression model below

Math and Science Index = - 0.24 + 0.519 log GNI per Capita,

estimates how much GNI per capita is contributed to the mathematics and science performance of the students. With an obtained R^2 of 55.3%, the proportion of variance contributed by the GNI per capita to the mathematics and science index means that more than half of the portion of mathematics and science performance of the students was explained and can be caused by the said independent variable.

The results above revealed that the direct effect of the class sizes is of greater significance than that of the direct effect of the budget in terms of GNI per capita on the mathematics and science performance of the students. Furthermore, when the proportion of variance from these two independent variables was combined, it gave an R^2 of 89.1% as the proportion of variance of the two predictive variables. The regression model below explains the proportions of variances of the combined independent variables as they influence the mathematics and science performance of the students.

Math & Science Index = 6.47 - 0.103 Class size - 0.000025 GNI per capita

This result shows that a large percentage of the student's mathematics and science performance is caused by the student–teacher ratio and the GNI per capita. This implies that to have a small class size, a budget allotted for education is needed. Since the researcher strongly believed that budget adequately contributes to the mathematics performance of the students, an investigation of whether GNI per capita has something to do with the student–teacher ratio was calculated.

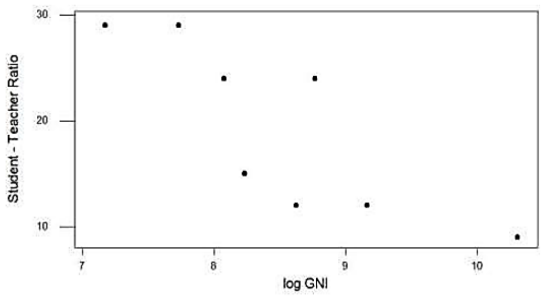

Figure4. *Student _ Teacher Ratio and Gross National Income per Capita*

The figure above shows that the higher the student–teacher ratio will be, the lesser the GNI per capita of the country becomes. To verify this notion, another regression analysis was conducted and observed. The mathematical model presented below explains the relationship between the budget through GNI per capita and the student–teacher ratio (ST) among these ASEAN countries. This equation model also tells how much national productivity or budget is needed in terms of GNI per capita to support the optimal class sizes.

ST = 78.1 − 6.92 log GNI

This result indicates that the higher the GNI per capita will be, the lower the student– teacher ratio will become. Indeed, the calculated R^2 suggests that 66.2% of the implementation of student–teacher ratio can be explained or caused by GNI per capita. This implies that the budget for educational purposes is very important in providing quality education. Moreover, the regression model above suggests a needed budget of *6.92 x log GNI per capita* to attain the desired student–teacher ratio. For example, to illustrate how much budget is needed to have for ten students, the formula is needed as follows

10 = 78.1 − .92 log GNI

6.92 log GNI = 78.1 − 10

6.92 log GNI = 68.1 log GNI = 9.841

$GNIpercapita$ = 18, 788.5

This tells that the budget to be allotted by the government for the ten students would be approximately 18, 788.5 dollars.

Finally, the researcher desires to determine the optimum number of student–teacher ratio needed to improve the mathematics and science performance of the students. Using the regression model below

Math & Science Index = 5.09 + 0.006 TS – 0.00224 TS^2

and finding the derivatives of ST (student–teacher ratio) through finding the change in Y with respect to ST, a calculated rounded value of 2 was obtained. This number suggests the optimal class size needed to enhance the performances of the students in mathematics and science. This means that governments of ASEAN countries must implement a 1:2 ratio for class size to optimize its effect on the mathematics and science index of their country. However, this is quite impractical since many of the ASEAN countries belong to low–income countries in the world. An alternative is then suggested to determine a more feasible number of students – teacher ratio. This is by observing two of the leading ASEAN countries in terms of their Mathematics and Science index and student–teacher ratio. From the data presented in Figure 2, Malaysia and Singapore have an average of 12 students in every teacher. With this, other ASEAN countries may follow the practice of having this class size to at least obtain the desired effect of smaller class sizes on the mathematics and science index of their country.

5. Conclusions and Recommendations

The regression analysis was used in this paper to assess the extent of influence of the two independent variables, student–teacher ratio and GNI per capita, on the dependent variable, which is the mathematics and science performance index of the 8 Southeast Asian Countries. Based on the results of the study, the mathematics and science performance of the students is highly influenced by the size of the class, which in turn is influenced by the budget allocated for education. Moreover, it is suggested that ASEAN countries must at least implement the suggested 12 student–teacher ratio to enhance their students' mathematics and science index. Thus, the governments need to look into and review the budgetary requirements in mathematics and science education in order to gain more returns in terms of GNI per capita for their country.

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