**How school size and student teacher ratio affecting the students' mathematics achievement**

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**Abstract**: Many different arguments have been offered in order to explain how social economic, student attitude and school size might affect mathematics achievement. This study aims to know factors affecting students' mathematics scores in Indonesia from PISA 2018 data by considering both student level and school level. Total observation used in this study were 9,090 students from 308 schools. using multilevel models for fitting the data the result showed that the index of economic, social and cultural status (ESCS), attitude towards school (ATTNACT) and school size were signigicant factor affecting the students’ mathematics achievement, but not the student-teacher-ratio (STRATIO).

1. **Introduction**

PISA is *Programme International Student Assessment* that is organized by *Organization for Economic Co-operation and Development* (OECD)*.* This world level assessment is done every three years, monitoring results education system's related students' 15 old. PISA tests three studies field, reading literacy, mathematics literacy, and sains. For the first time, Indonesia follows in PISA 2000, which Indonesia got rank 39 from 41 countries and it reached score 367, after that 2003, Indonesian reached 360 score and it got rank 38 from 40 countries (Indonesia PISA Center) and then new information in PISA 2018 which Indonesia got average 377 scores and it got rank 74 from 80 countries which follow PISA.

Therefore, important is noticed what factors affect reading literacy, mathematics literacy, and sains students in Indonesia. Several research had discussed relation student-level dan school level with student achievement. Mc leyd states that gender differences in mathematics in which man was more dominant high. In addition, gender, characteristics background of students such as language, Index of economic, social and cultural status, and complete family found positive relation with students achievement i.e reading literacy, mathematics literacy, and sains literacy [2]. Moreover, [9] [16] result of research suggests who students school in urban and high SES tend better from their friend who studies in rural, private, and low SES. The last [6] [11] lower student-teacher ratio, teacher shortage trained, poor school educational quality resources and adverse school climate affected students’ achievement.

 Therefore, several factors corresponding both student level and school level with student achievement. Consequently, this research uses analysis *Multilevel Modelling* to look factors both student level and school level with student achievement in mathematics literacy.

1. **Literature Review**

*Individual Level Characteristics*

There are several factors student level that affect to result of students' mathematics achievement, where several are characteristics such as family's social-economic status (ESCS) and attitudes towards school which affect student mathematics achievement.

*Index of economic, social, and cultural status* (ESCS)

Panner say family's with ESCS sufficient or higher to tend success preparing their children for school. Besides, parent's income was related with student achievement and it was followed by parents’ job and education [12] [13]. Another opinions said student who attend school large places and school with excellent educational resources was significant in mathematics achievement, indicating that student who high ESCS will get high score[1] . Demir and friend in their research told that student who had high ESCS will get high mathematics score. High or low ESCS was suspected to influence of high and low scores obtained by the assumption that was equival to PISA score that develoed coutries had the hig score comared to develop [14]. In addition, some studies axamining the ESCS is positive correlation between the students socioeconomic status and their achievement in learning mathematics [14M]. In general, there is a commonality of the world research literature about ESCS that students whose family backgroud was high ESCS perform better than other student [9]. And than, Karakolidis argue that childrens schooling and give less support to children as compared to parents from families with a high SES, resulting in low academic achievement. ATTNACT *(Attitude towards school)* defined attitude as evaluative disposition toward a subject was comparised of cognitive, affective and behavioral aspects, which get predict knowledge level and affective reaction **[**26**]**. Attitude toards learning have concetually linked with students’ engangement in school activies, their school axperiance and than their dedication to schooling [OECD 13c]. In addition [1] said that student had excellent positive attitude will get a high score in PISA assessment in particular mathematics achievement. But, this finding was contrast with Lee, he said ATTNACT did not statistically significant with mathematics achievement [11].

*School Level Characteristics*

Student-teacher ratio state relationship between several students enrolled in school, district, or education system, where several teachers equivalent full time employed by the school. The low student-teacher ratio will affect student achievement caused shortage of quality trained teachers and negative school education resources [7]. In addition, researh result [1] that STRATIO not significantlly with mathematics achievement from china sample, but from US, Japan and Finlan are significantlly with mathematics achievement. But, this finding was contrast with Shaljan, he said if STRATIO statistically significant with mathematics achievement. The above studies mostly found debate between STRATIO variable with student mathematics achievement. Therefore this variable needs to examin again to strangthen the result of previous studies. *School size* has a definition potential factor to affect student academic achievement, in particular, results in mathematics [6]. Therefore, research [9] that school size show positive effect both small and large schools with student achievement. In addition, [ESCS] said that school size had significantlly positive effect on students’ mathematics literacy in US, Finladia and Japan. Giobona et al that larger schools are able to offer wider curricular and extra curricular oppotunities and a concomitant increase in teacher specialization. Therefore, students’ achievement can increase in very large schools.

1. **Method**

 **3.1 PISA design**

This study conducted secondary analyses based on the PISA 2018 data set retrieved from the official website PISA (OECD). The data are a result of PISA 2018 for Mathematics scores. Indonesia sample comprised 9090 students selected 308 schools in PISA 2018. Dependent variable is student achievement measured from PISA 2018, specifically mathematics achievement.

In addition, independent variabel (predictor) is consists of 2 group, student level (ESCS and ATTNACT), while the second school level (STRATIO and SCHSIZE). The fourth variabel are chose because there are very importan in success of students’ education and than this variables have researched by previous research which explain that this variables are strong influence on student learning outcome, especially study mathematics

**3. 2 Data**

This PISA data analysis use *Two Level Multilevel Model,* which this model is developed to explore what factors affect students' mathematics scores at both student level or school level. The purpose of a hierarchical structure where students nest in class and nest classes in school and nested schools in districts and nesting districts in provinces and another [4]. In this case, multilevel analyses are recommended to used because of the hierarchical structure. Therefore each of these levels (student and schools) are represented by their model sub own. The intent of this sub-model will determine how the influence of the variable's highest level can influence the characteristics of Indonesian students' scores in PISA 2018. *Hierarchical linear modeling* (HLM) structure useful for analyses score students different levels to control variance inter levels. This study sees, what PISA score 2018 IDN student relate with ESCS and ATTNACT student level and connecting with STRATIO and SCHSIZE school level. How interesting student-level predictors and school-level predictors are related simultaneously IDN students PISA score. Therefor that two-level models are suitable for analyzing data.

The first question what are PISA score student IDN connect with ESCS and ATTNACT (level 1) ?, the second question what are PISA score student IDN relate with STRATIO and SCHSIZE (level 2) ?. This multilevel modeling process is divided into three models for each dependent variable where is (1) Null models, (2) models with student-level predictor, and (3) model with student level and school level predictor.

1. **Results**

Multilevel analysis used often to analyze data that has more than onepredictor level. In this study, multilevel analysis used to analyze predictor student level and school level. The results of analysis carried out to summarize in **Table 1**. In general, the big influence of design is used 17.57 with number of subjects 9090 from 308 schools. Result is calculation ICC and Design effect i.e :

$ICC= \frac{τ\_{00}}{τ\_{00}+σ^{2}}$ (1)

$ICC= \frac{3627}{3627+2614}=0.58$ (2)

Peugh thathad showed ICC values 0.58 to be common in cross-sectional MLM applications, but if non zero ICC estimate alone doesnt’ necessarily indicate the need for multilevel analyses.

$Design effect=\frac{1+(n\_{cc}- 1)}{ICC}$(3)

$Design effect=\frac{1+(29.51- 1)}{0.58 }=17.57$(4)

And than design effect estimate greater than 2.0 indicate a need for MLM.

**Table 1**. Fixed effects estimates and variance covariance estima for models of the predictors of mathematics achievement

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | Unconditianol model  |  | Level – 1 model  |  | Level – 2 model  |
| B | SE |  | B | SE |  | B | SE |
| Intercept  | 391.39 | 3.49 |  | 397.18 | 3.5010 |  | 362.18 | 6.89 |
| Level – 1 |  |  |  |  |  |  |  |  |
| ESCS |  |  |  | 4.11 | 0.63\*\* |  | 4.02 | 0.63\*\* |
| ATTLNACT |  |  |  | 2.23 | 0.56\*\* |  | 2.21 | 0.56\*\* |
| Level – 2 |  |  |  |  |  |  |  |  |
| STRATIO |  |  |  |  |  |  | -0.31 | 0.37 |
| SCHSIZE |  |  |  |  |  |  | 0.06 | 0.00\*\* |
| Intraclass correlation coefficient | 0.58 |  |  | 0.58 |  |  | 0.58 |  |
| Variance in achievement between schools  | 3627 |  |  | 3357 |  |  | 2572 |  |
| Variance in achievement within schools | 2614 |  |  | 2605 |  |  | 2604 |  |

Parameter estimate standard error listed in parentheses

\*\* *p* < 0.01

* 1. *Step 1 : Null model*

Random effect model is created to serve this purpose (1) . this model is random effect model without predictors that allow to measure effect inter school and intra school student mathematics score. This model predict means score of students’ (mean intrcept) for all schools is 391.39 points in mathematics test.

$mathscore\_{ij}=β\_{0}+u\_{0j}+e\_{ij}= 391.39$ (1)

This indicate that 0.38% variantion total attributes to differences between school, therefore, 23% of varince total is attributes to within schools difference. Variation mathematics achievement derives mostly from within schools than to between school variance.

4. *2 Step 2 : adding student level predictor variable*

 This equation is a null model with addition of all student level predictor variables.

$mathscore\_{ij}=397.18+4.11\_{ESCS}+2.23 \_{ATTLANCT}$ (2)

Where $u\_{0j} $ is school effect j on independent variable.

 ESCS and ATTLANCT variable coefficient is positive, so increasing economic level of students’ get good effect achievement of mathematics scores.

4.3 *Step 3 : adding student level predictor and school level variable*

 The final stage of the multilevel analysis create model fitting with predictor both student level and school level.

$mathscore\_{ij}=397.18+4.02\_{ESCS}+2.21\_{ATTLANCT}+-0.31\_{SCHSIZE}+0.06 \_{STRATIO +}\_{}$ (3)

SCHSIZE variable coefficient is positive, so a large school size get good effect achievement of mathematics scores. But, STRATIO variable coefficient is negative, along with increasing ratio size doesnt’ affect achievement of mathematics score

ICC can define such as mathematics achievement proportion score variation that occurs across school and correlation is axpected between mathematics achievement score of two students’ from same school. Previos result seen that $0.58 $ICC values $ $and 17.57 design effect values. this result same with research eug said that Multilevel used if ICC values > 0 and Design effect > 2.0. therefore, these result stated mean mathematics achievement score variation across school. These result qualify to use *Multilevel modeling analysis*. But, if ICC values = 0 then it is state not mean mathematcs achievement score variation across school and than al mathametcs achievement score variation occurs across student.

 Tabel 1 seen if predictor level 1 (i.e ESCS and ATTLNACT) obtained statistically significantly with mathematics achievement which obtained score p-value < 0.01 , ESCS had to score p-value = 0e+00 < 0.01. these result indicate socialeconomic that affect mathematics achievement in PISA 2018. This result is same with [19] research, which *Socio-Economic* is a factor that is strongly with mathematics achievement in PISA . Moreover, the study [20] noted that socioeconomic status statistically significantly with Mathematics achievement in PISA 2012 and then same result from [7] said that statistically significantly with Mathematics achievement and ESCS had strong influence in mathematical achievement. The results line with previous theoretical studies, while ATTLNACT obtained score p-value = 1e-04 < 0.01 in line with previous findings where students who had an excellent positive attitude toward school will get a better PISA score. In addition, [17] said that students' attitudes towards school had a significant influence with mathematics achievement in PISA result. This result strengthened that students' attitude towards school (ATTLNACT) to be one-factor PISA score 2018 in mathematics achievement. After that, adding STRATIO and SCHSIZE as predictor level 2 which were obtained to result for ESCS, ATTLNACT, STRATIO and SCHSIZE are used to predict mathematics achievement, for ESCS, ATTLNACT, and SCHIZE had a statistically significant relation with mathematics achievement which they obtained score pvalue 0.0000 < 0.01, whereas STRATIO did not have a statistically significant relationship with mathematics achievement which has obtained score pvalue 0.4002 > 0.01. in addition [8] said that STRATIO statistically significant relation with mathematics scores for country Bulgaria, Russia, Serbia, and Israel. Therefore, in his article said that student success in mathematics had influenced differently from a variable (gender, ESCS, home education resources, cultural possession, memorization, control strategy, STRATIO, SCHIZE) all variables are statistically significant on the success of mathematics score, but for STRATIO did not have a statistically significant relationship on the success of mathematics score.

1. **Discussion**

Social-economic is related solely to result in mathematics score. Where students had good social economic and adequate will get a higher rating from student had less social-economic, because students who had sufficient economic, they followed courses as additional study outside school hours to get additional information. Whereas, students who less social-economic only got information have given by their teacher at school. These results are lines with findings[1].

 Moreover, positive attitudes against school-related result score mathematics, because students who had good attitudes with their teacher and their friends at school affect mathematics scores in PISA 2018 These results are lines with findings[17].

 In the school level, *School Size* (SCHSIZE) related to result from mathematics score because student attend school inadequate school size, and good educational resources will meet learning process facilities and helped student to get more information and knowledge. Therefor *school size* affected to result mathematics score Indonesia student. But, unlike *school size* for STRATIO from calculation result did not have influence or relationship with mathematics score Indonesia student. This result was consistent with the outcome of prior art [12]. So, answering was the first question that predictor student level where a variable is ESCS, and ATTLNACT had to affect significantly with PISA score in Mathematics. Whereas, the second question got to result that variable SCHSIZE had to affect significant with PISA score, but for variable STRATIO not significant with PISA score. Therefore, this result has answered questions that predictor student level and school level are simultaneously associated with PISA score 2018 Indonesia student.

1. **Conclusion**

Result of study emhasized the imortance of socialeconomic, attitude toard school and school size in prediction of students’mathematics achievement in Indonesia. in addition, finding indicate that policy makers, namely central, local governments educators and parents should take into consideration and than parents should take into socialeconomic, student teacher ratio and school size when designing educational policies, program and curricula. Moreover, it is evident that the school itself should properly manage its important role in shaping mathematics achievement. Overall, this study represents Factors that affect students' Indonesia mathematics scores PISA 2018 in the student-level are *Index of economic, social, and cultural status* (ESCS) dan *Attitude towards school* (ATTLNACT). Whereas for school level school is *School size* (SCHSIZE), but *Student-teacher ratio* (STRATIO) not significant with mathematics score because which has score p-value > 0.05.

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