**The Effects of Teachers’ Motivation and Supports,**

**Parents’ Motivations and Digital Learning**

**on Students' Mathematics Achievement: Indonesian case from PISA 2018**

Adhar Rizki Mustafa1) and Kismiantini2)

1*) Magister Student of Mathematics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Jl. Colombo 1, Daerah Istimewa Yogyakarta, Indonesia*

*2) Department of Statistics, Universitas Negeri Yogyakarta, Jl. Colombo 1, Daerah Istimewa Yogyakarta, Indonesia*

Author Emails

a)adharrizki.2021@student.uny.ac.id

b)kismi@uny.ac.id

**Abstract.** Many learning theories say that raising students' cooperative attitudes, competitive attitudes, and paying attention to the teacher's teaching style in every lesson are appropriate actions in learning that may improve the student achievement. This study uses data from the PISA 2018 Indonesia to investigate the factors that influence the mathematics achievement of 15-year-old students. The hierarchical linear model was used to examine the factors from the perspective of students and schools. At the student level, the results showed that the students who studied cooperatively, students with a highly competitive spirit, students with high self-efficacy, and students who were taught by creative teachers had a significant effect on students' mathematics achievement. Female students had higher mathematics achievement than male students on average. At the school level, the findings revealed that differences in mathematics achievement can be explained by school status, with public schools outperforming private schools.

# INTRODUCTION

PISA (the program for international student assessment) is a program to measure achievement for 15 year olds in the areas of math, science and reading literacy. The assessment carried out by PISA is carried out every 3 (three) years with a focus on the education of a country. The countries that have participated in the PISA assessment since it was first conducted, namely since 2000 have continued to grow, recorded until 2018 from 41 to 79 countries as participants in the PISA assessment under the Organization for Economic Co-operation and Development[1]. The tests in PISA are diagnostic to provide useful information for the education system. PISA differs from other tests in that it does not link a direct approach to the school curriculum. In addition, students and school principals were also asked to answer about their background in life, school and work experience, as well as the school system and learning environment[2].

Program for International Student Assessment study results (PISA) 2018 was released on Tuesday, December 3, 2019. Based on the results of the study, Indonesia's 2018 PISA Ranking has fallen when compared to the 2015 PISA results. This 2018 study assessed 600,000 15-year-old children from 79 countries every three years. . The study compared the math, reading, and science performance of each child. for the mathematics category, Indonesia is ranked 7th from the bottom (73) with an average score of 379. Indonesia is above Saudi Arabia which has an average score of 373. Then for first place, China is still occupied with an average score of 591. Then for the science performance category, Indonesia is ranked 9th from the bottom (71), with an average score of 396. It is above Saudi Arabia which has an average score of 386. China occupies the first place with an average score of 590[3].

The establishment of PISA aims to encourage and facilitate low- and middle-income countries that want to participate, contribute, and be motivated. PISA also aims to improve educational development for quality and equity of learning outcomes for children, youth, and adults. The PISA 2018 data set contains responses from individual students, school principals, teachers, and parents. Furthermore, improving educational quality throughout the analysis of PISA data at various levels can be beneficial to education policymakers[4].

Motivation is a condition that is owned by every student to behave. The potential that students have is different, as well as how to develop their potential. How to develop depends on the desires of each student. This is influenced by the motivation of each individual. Teacher motivation is one of the determining factors student achievement. Because with the motivation of the teacher, the interest of a student grows to continue to learn in order to achieve the ideals according to what he wants. Motivation when combined with the learning process and supported by learning styles, methods, media and other adequate facilities and infrastructure will certainly produce quality output. Teacher professionalism in teaching and educating is also a supporting factor for student success[5].

Within the family itself, there is an important role of parents who can support success in creating harmony between family members. Where parents can be interpreted as two human figures consisting of a man and a woman, who have been bound by marriage ropes to become husband and wife and become the main pillars of the birth of a family. The main task of parents in this case is to lead their children to achieve a better life of achievement in the family, school, and community. In other words, the higher the level of care and attention of parents, the easier it will be for children to achieve the expected learning achievements. This is in accordance with the results of research from Robert and Henry on the development of children who do not receive parental care and attention, where they conclude that children who do not receive parental care and attention tend to have decreased academic abilities or poor learning achievements, hampered social activities. , and limited social interaction. One of the internal factors that affect learning achievement is learning motivation. Students who have high intelligence sometimes achieve low learning achievements, due to their intellectual abilities not functioning optimally. One of the supporting factors so that students' intellectual abilities can function optimally is the existence of high achievement motivation. Motivation is an impulse that exists in humans that causes behavior towards a certain goal. Motivation also means driving behavior towards goals based on a need. Achievement motivation is a driving force for individuals to always achieve better achievements than before. The strength or weakness of the efforts made by students in achieving the goals or achievements to be achieved depends on the achievement motivation that is in him, there is a lot of evidence that children do not develop because they do not get the right motivation. From this understanding of motivation, three things appear, namely: 1. motivation begins with a change in energy from within a person, 2. motivation is characterized by affective impulses that are sometimes visible and sometimes difficult to observe, 3. motivation is characterized by reactions to achieve goals. By having a strong motivation, the individual will try hard to achieve his goals. Individual motivation varies, some have strong motivation, some are moderately motivated and some are weak, so this motivational factor is one of the factors that has an important role in the intensity of student learning so that it determines their learning achievement.

Developments in the field of information and communication technology that are so fast in modern times like today create a new culture or culture for human beings in all parts of the world. The world of education which has been integrated by information technology has had a great influence on the world of education itself. To improve quality, educational efficiency can be created by utilizing the sophistication of Information Technology. The quality of education of a nation is one of the components for the progress of the nation. Therefore, it takes a role and good use of technology is very important in improving the quality of education in order to create educational welfare for the nation. According to Ibrahim in Sutirna (2018) said that educational innovation is innovation in terms of solving problems in the field of education or commonly called innovation in the field. So innovation in the field of education is an item, method, or idea that is observed or felt as something new that is used to achieve educational goals or to solve problems in the field of education. One of the innovations in this case is learning that utilizes technology which is expected to be a solution to problems in the world of education today. With new ideas generated by technology such as models, approaches, methods, evaluations, and learning media, it is hoped that it can improve the quality of education which is a factor in better student learning outcomes and is accepted and needed by the community. Therefore, digital learning comes with a new innovation which is a learning process where students are invited to use technology as a source of student learning.

# METHOD

## Data Collection

The data set used in this study is PISA 2018 Indonesia data. PISA takes place every three years, since 2000, and focuses on a specific domain in each cycle (reading, math, or science). The PISA aims to encourage and facilitate participation from low- and middle-income countries. The assessment focuses on reading, math, science, and innovative domains proficiency, as well as student well-being [6]. The PISA 2018 Indonesia dataset includes all observations from 12,098 students and 397 schools. The response variable is the student mathematics achievement that is calculated by averaging ten plausible values in mathematics. In this study, two levels in PISA 2018 Indonesia are of concern: students (level 1) and schools (level 2). The predictors of level 1 in this study were parents’ motivation and teachers’ motivation. The predictor of level-2 was digital learning. As the missing values in the variables of interest were discovered, the sample size became 9.645 students and 334 schools.

Assessment of parents’ motivation can be measured from the statements (student level): “My parents support my educational efforts and achievements (ST123Q02NA).”, “My parents support me when I am facing difficulties at school (ST123Q03NA).”, “My parents support me when I am facing difficulties at school (ST123Q04NA)”. Each statement is assigned with a response code, 1: Storongly disgree, 2: Disagree, 3: Agree, 4: Strongly agree. Parents’ motivation is a variable that show student views on their parents’ motivation to their learning achievement. Students who value of parents’ motivation is high will motivated to continue to learn and develop their skills. Students with very low parents’ motivation are assigned code 1, while students with very high parents’ motivation scores are assigned code 4.

Assessment of teachers’ motivation can be measured from the statements (student level): “The teacher shows an interest in every student’s learning (ST100Q01TA).”, “The teacher gives extra help when students need it (ST100Q02TA).”, “The teacher helps students with their learning (ST100Q03TA).”, “The teacher continues teaching until the students understand (ST100Q04TA).”, “The teacher made me feel confident in my ability to do well in the course (ST211Q01HA).”, “The teacher listened to my view on how to do things (ST211Q02HA).”, and “I felt that my teacher understood me (ST211Q03HA).”. Each statement is assigned with a response code, 1: Storongly disgree, 2: Disagree, 3: Agree, 4: Strongly agree. Teachers’ motivation is a variable that show student views on their teachers’ motivation to their learning achievement. Students who value of teachers’ motivation is high will motivated to continue to learn and develop their skills. Students with very low parents’ motivation are assigned code 1, while students with very high parents’ motivation scores are assigned code 4.

The variable at level-2 (school level) is measured by the number of statements as follows: “The number of digital devices connected to the Internet is sufficient. (SC155Q01HA).”, “Sufficient bandwidth or school Internet speed. (SC155Q02HA).”, “The number of digital devices for instruction is sufficient. (SC155Q03HA).”, “The number of digital devices for instruction is sufficient. (SC155Q04HA).”, “Availability of adequate software is sufficient. (SC155Q05HA).”, “Teachers have the necessary technical and pedagogical skills to integrate digital tools into teaching. (SC155Q06HA).”, “Teachers have sufficient time to prepare lessons on integrating digital devices. (SC155Q07HA).”, “Effective professional resources are available for teachers to learn how to use digital tools. (SC155Q08HA).”, “An effective online learning support platform is available. (SC155Q09HA).”, “Teachers are given incentives to integrate digital tools in their teaching. (SC155Q10HA).”, and “The school has qualified technical assistant staff. (SC155Q11HA)”. Each statement is assigned an answer code, 1: Strongly disagree, 2: Disagree, 3: Agree, 4: Strongly agree. Digital learning is one of the factors that have a major influence on the success of learning mathematics. Students with good digital learning quality are assigned a code of 4, while students with low digital learning quality are assigned a code of 1.

## Data Analysis

It consisted of 9.645 students and 334 schools with completed responses for all variables used to investigate the effect of gender, student’s cooperative attitudes, competitive attitudes, self-efficacy, teacher teaching style, and school status to mathematics achievement using two-level multilevel models. The descriptive statistics provides the basic features of the variables. Pinheiro et al said the data were analyzed by the R studio version 4.1.2 software by using the lme function from the nlme package [4]. Three random intercept models and one random slope model in the multilevel framework were fitted to the data. The best model is determined by the lowest values of the Akaike Information Criteria (AIC) and the Bayesian Information Criteria (BIC). In the PISA 2018 data, it contains hierarchical structure of the data, which are school-level and student-level. Hence, the multilevel analysis is an appropriate statistical method for analyzing PISA data. First, the simplest model is the null model or the model without predictors. The null model can be written as follows.

$y\_{ij}=γ\_{00}+U\_{0j}+ε\_{ij}$ (1)

where *ij* represents the ith student in the jth school. Model (1) has fixed component and a random component. The fixed component is a variable that has the same value across all schools, while the random component has a different values across schools. The fixed and random components in model (1) respectively are $γ\_{00}$, $U\_{0j} $and $ε\_{ij}$. The model cannot explain the impact of the predictor variable on the response variable in the study. However, the model can provide information about variance within ($σ^{2}$) and across the schools ($τ^{2}$). Those variances are used to calculate the Intra Class Correlation (ICC) coefficient, where this value is the indicator of the use of the multilevel model in the study. The ICC formula is presented as follows.

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

Where $σ^{2} $is variance of mathematics scores across students in the school and $τ\_{00}$ is variance of mathematics scores across schools. ICC is a measure of the proportion of variation in the outcome variable that occurs between groups versus the total variation present. Peugh said that ICC values between 0.05 and 0.20 are common in stratified modeling in research studies [7]. The need for stratified analysis is based not only on non-zero ICC but also the design effect. The design effect is used to justify the stratified accounting structure in the analysis [8]. The design effect is determined by

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

where $n\_{c}$ is the number of students per school. The design effect value which is greater than 2.0 indicated the need for multilevel modeling [7], [9].

In this study, there are three independent variables at the student level: parents’ motivation, teachers’ motivation, teachers’ support, and one dependent variable at the student level that is the mathematics achievement. The independent variable at the school level is digital learning.

# RESULTS AND DISCUSSION

## Descriptive Statistics

The number of students in Indonesia's 2018 PISA data were 12,098. After reducing the incomplete data, the number of students became 9.645 students. Based on the results of the analysis in Table 1, the average score of Indonesian students was 403.8. This score is below the PISA 2018 worldwide average (standard score) of 489. This is an average of 9.645 students. The highest score of mathematics achievement obtained by students was 677.7 while the lowest score was 132.8.

**TABLE 1.** Parents’ Motivation, Teachers’ Motivation and Support, and Digital Learning on

Students' Mathematics Achievement

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Average** | **1st Qu.** | **3rd Qu.** | **Minimum** | **Maximum** |
| Math Score | 403.8 | 347.7 | 455.4 | 132.8 | 677.7 |
| Parents’ Motivation | 10 | 9 | 12 | 3 | 12 |
| Teachers’ Motivation | 6.562 | 4,000 | 8,00 | 4,000 | 16.00 |
| Teachers’ Support | 12.1 | 11.0 | 13.0 | 4.0 | 16.0 |
| Digital Learning | 31.37 | 27.00 | 36.00 | 11.00 | 44.00 |

## Multilevel Model Analysis

At this stage, the model uses Parents’ Motivation, Teachers’ Motivation and Support, and Digital Learning as predictor variables and mathematics achievement variable as the dependent variable for analysis using a multilevel model. The following is the result of fitting the model:

**TABLE 2**. Multilevel analyses results for the four multilevel models.

| **Parameter** | **Model 1(SD)** | **Model 2(SD)** | **Model 3(SD)** |
| --- | --- | --- | --- |
| *Regression coefficients (fixed effects)* |
| Intercept $(γ\_{00})$ | $$393,6558^{\*\*\*}$$ | $$364.9623^{\*\*\*}$$ | $$317.7224^{\*\*\*}$$ |
| Parents’ Motivation |  | $$2.5792^{\*\*\*}$$ | $$2.5831^{\*\*\*}$$ |
| Teachers’ Motivation |  | $$-0.0018^{\*}$$ | $$-0.1835^{\*}$$ |
| Teachers’ Support |  | $$0.2521^{\*\*\*}$$ | $$0.2178^{\*\*\*}$$ |
| Digital Learning |  |  | $$1.5932^{\*\*\*}$$ |
| *Variance components (random effects)* |
| Residual $(σ^{2})$ in school | 2595.523(50.946) | 2566.608(50.6617) | 2535.380(50.352) |
| Intercept $(τ\_{00})$ between school | 3605.793(60.048) | 3518.717(59.318) | 379.920(19.491) |
|  |  |  |  |
| *Information criteria* |
| AIC | 104390 | 104283.4 | 104227.5 |
| BIC | 104411.5 | 104326.7 | 104378.2 |

Parameter estimates and standard errors are listed in parentheses

$$\*\*\*p<0.001, \*\*p<0.01, \*p<0.05,$$

**TABLE 3.** The Estimated Regression Equations of Three Multilevel Models

| **Model 1** | **Model 2** | **Model 3** |
| --- | --- | --- |
| $$y\_{ij}=393,6558+U\_{0j}$$ | $$y\_{ij}=364.9623+2.5792x\_{1ij}-0.0018x\_{2ij}+0.2521 x\_{3ij}+U\_{0j}$$ | $$y\_{ij}=317.7224+2.5831x\_{1ij}-0.1835x\_{2ij}+0.2178 x\_{3ij}+1.5932 x\_{4j}+U\_{0j}$$ |

Model 1 is the random intercept model without predictor, Model 2 is the random intercept model with the predictors of level 1, Model 3 is a random intercept model the predictors of level 1 and level 2.

Intraclass correlation coefficient $( ICC)=\frac{\hat{τ}\_{0}^{2}}{\hat{τ}\_{0}^{2}+\hat{σ}\_{0}^{2}}=\frac{3605.793}{3605.793+2595.523}=0,581456$. The ICC shows that the diversity of mathematics achievement between groups is almost the same because the ICC score is quite high, namely 0.58. ICC estimates indicate that 58% of the variance in mathematics achievement occurs across schools and 42% of the variance within schools.

$Design Effect=1+(n\_{c}-1)ICC =1+(\frac{9.645}{334}-1)0,58$ $=16.1688.$

If the $ICC\geq $0.05, the model is declared feasible to use. Because the ICC value is quite large 0.58, it indicates that the random intercept model without predictors is feasible to use. Furthermore, to consider that the model should use a multilevel model, it can be seen the Design Effect value on the model. After calculating, the *Design Effect* value is $16.1688$. This value of $16.1688 $indicates that the model should use a multilevel model for student mathematics achievement data from the PISA 2018 Indonesia.

The estimated ICC and design effect values from the results of model 1 indicates the need for a multilevel model in analyzing the data. As a follow-up, level 1 predictor variable (Parents’ Motivation, Teachers’ Motivation and Suppor) were added to the model 1. After adding two level 1 predictor variables to the model, the random intercept model revealed that the mathematic achievement score of Indonesian students was statistically significant, $\hat{γ}\_{00}$ is 364.9623 (*p-value* < 0.01). All predictor variables level 1 were statistically significant with the estimated regression coefficients for the variables of parents’ motivation and teachers’ support objectives respectively 2.5792 (*p-value* < 0.01) and 0.2521 (*p-value* < 0.01). Interestingly, the teachers’ motivation was not significant to the inter-school students' mathematic achievement scores is -0.0018 (*p-value* > 0.05).

The results of the multilevel analysis of level 1 predictor variables explained that the score on the mathematics achievement for each student are predicted by the intercept that varies across school given the level 1 predictors of the parents’ motivation, teachers’ motivation and support. To allow the predictor variable to have a different effect for each school, a level 2 predictor variable was added to the model and analyzed to determine whether the variable could explain the remaining variables or not. In addition, the addition of a level 2 predictor variable can provide an in-depth analysis of the impact of these variables on students' mathematic achievement scores. After fitting the data with the random slope model, the results explained that the resilience and the implementation of digital learning were statistically significant predictors of students' mathematic achievement scores. The estimated regression coefficient of the parents’ motivtion is ($\hat{γ}\_{10}$) 2.5831 (*p-value* < 0.01), while for the teachers’ support is ($\hat{γ}\_{30}$) 0.2178 (*p-value* < 0.01), while for the digital learning is ($\hat{γ}\_{40}$) 1.5932 (*p-value* < 0.01). Interestingly, the teachers’ motivation was not significant to the inter-school students' mathematic achievement scores is ($\hat{γ}\_{20}$) -0.1835 (*p-value* > 0.05).

According to the AIC and BIC values from table 2, the random slope model is the best model as it has the lowest values of AIC and BIC. The variance of the intercept and residual components decreases from model to model. This means that the more complex the model, the lower the sample variance. Table 3 shows the estimated regression equations of the null model, the random intercept model, and the random slope model.

# CONCLUSION

This study revealed that the random slope model was the best model evidenced by lowest AIC and BIC values. The variables that are statistically significant to predict mathematic achievement scores among students in schools are parents’ motivation, teachers’ motivation and support, and digital learning. The parents’ motivation and teachets’ support had a positive relationship with the mathematic achievement score, while the teachers’ motivation had a negative relationship with the mathematic achievement score. Concern for education actors in developing student implementing digital learning in the classroom, because the digital learning has a positive relationship with the mathematic achievement score. In addition, there is a need for further research that examines the factors that influence mathematics achievement at the student and school level on Indonesian students' PISA results. It is intended that learning goals can have a positive influence on students' mathematic achievement and resulting in Indonesian students who can apply their knowledge and play a role in society.

# REFERENCES

[1] OECD, “Programme for international student assessment (PISA) results from PISA 2018.,” *Oecd*, pp. 1–10, 2019, [Online]. Available: https://www.oecd-ilibrary.org/education/pisa-2018-results-volume-iii\_bd69f805-en%0Ahttps://www.oecd-ilibrary.org//sites/bd69f805-en/index.html?itemId=/content/component/bd69f805-en#fig86.

[2] S. Breakspear, “How does PISA shape education policy making? Why how we measure learning determines what counts in education,” *Cent. Strateg. Educ. Semin. Ser.*, no. 240, pp. 1–16, 2014, [Online]. Available: http://simonbreakspear.com/wp-content/uploads/2015/09/Breakspear-PISA-Paper.pdf.

[3] M. Tohir, “Hasil PISA Indonesia Tahun 2018 Turun Dibanding Tahun 2015,” *Pap. Mat.*, vol. 2, no. 1, pp. 1–2, 2019, [Online]. Available: https://matematohir.wordpress.com/2019/12/03/hasil-pisa-indonesia-tahun-2018-turun-dibanding-tahun-2015/.

[4] Kismiantini, E. P. Setiawan, and A. C. Pierewan, “GROWTH MINDSET , SCHOOL CONTEXT , AND MATHEMATICS ACHIEVEMENT IN INDONESIA : A MULTILEVEL MODEL,” *J. Math. Educ.*, vol. 12, no. 2, pp. 279–294, 2021.

[5] H. S. Bunyamin and D. Faujiah, “Pengaruh Motivasi Guru Terhadap Prestasi Belajar Siswa Mata Pelajaran Ips Di Sdn Rajagaluh Kidul Kec. Rajagaluh Kab. Majalengka,” *Al Ibtida J. Pendidik. Guru MI*, vol. 1, no. 2, 2014, doi: 10.24235/al.ibtida.snj.v1i2.349.

[6] OECD, “2018 Database - PISA,” *2018 Database - Programme for International Student Assessment (PISA), Organisation for Economic Co-operation and Development.* 2018.

[7] J. L. Peugh, “A practical guide to multilevel modeling,” *J. Sch. Psychol.*, vol. 48, no. 1, pp. 85–112, 2010, doi: 10.1016/j.jsp.2009.09.002.

[8] C. J. M. Maas and J. J. Hox, “The influence of violations of assumptions on multilevel parameter estimates and their standard errors,” *Comput. Stat. Data Anal.*, vol. 46, no. 3, pp. 427–440, 2004, doi: 10.1016/j.csda.2003.08.006.

[9] B. O. Muthen and A. Satorra, “Complex Sample Data in Structural Equation Modeling,” *Sociol. Methodol.*, vol. 25, no. May, p. 267, 1995, doi: 10.2307/271070.