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Identifying the effects of financial literacy on student achievement in mathematics

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Abstract

Quality education is critical to produce a quality generation of the country. However, the quality of Indonesian education is still lagging behind other countries. An analysis is needed to identify student and school factors that affect student achievement. In this study, the student factors were financial literacy ability and parents' educational background. Meanwhile, the school factors were accreditation scores. The data used in this study is the data of Indonesian Student Competency Assessment (AKSI) which is an education monitoring program through a survey using the Multistage Probability Sampling method. Since the data has a hierarchical structure, multiple regression analysis will produce biased parameter estimates. Therefore, multilevel regression analysis was used in the study to solve that problem. The random slope model with interaction is the best multilevel regression model for this study. The quality of schools as described by accreditation scores and students 'abilities in financial literacy, such as students' attitudes before buying goods, the ability of finance, and the intensity in taking financial action have a significant effect on student achievement in mathematics. The educational background of parents also has a significant effect on student achievement. The effect of these variables differs between schools due to the accreditation score of each school.

Keywords: AKSI; financial literacy; Hierarchical data; Multilevel regression

1. Introduction

One of the current problems is that the quality of education in Indonesia is still lagging compared to other countries [1,2,3,4]. The government maps the quality of education based on a National Examination to measure the competence of graduates which refers to the Graduate Competency Standards (SKL). In addition, the government also participates in the Program for International Student Assessment (PISA), an international study of literacy achievement in reading, science, and mathematics organized by the Organization for Economic Cooperation and Development (OECD). Based on the 2019 UN results report, student's abilities in mathematics, language, and science is still inadequate. The average achieved by junior high school students in these subjects is only 51.7 (https://npd.kemdikbud.go.id/?appid=hasilun). The 2018 PISA results also show that Indonesian students score below the OECD average in both reading literacy, mathematics, and science (OECD, 2018). These results indicate that the quality of education in Indonesia is still low.

The government is making efforts to improve the quality of education by organizing an education quality monitoring program through a survey. The program is named as the Indonesian Student Competency Assessment (AKSI) organized by the Center for Assessment and Learning-Ministry of Education and Culture (Pusmenjar-Kemdikbud) [5,6]. It is assessment an assessment program which is used to see students' abilities on important topics in mathematics, science, and reading subjects. The AKSI survey aims to identify student, teacher, and school factors that affect student achievement which form the basis for the formulation of policies and programs to improve the quality of learning and the quality of education [7].

AKSI 2019 was implemented in July-August 2019, and targeted for 9 students in sample schools spread across all cities or districts in Indonesia. The AKSI instrument consists of a questionnaire from the principal, teachers, and students.

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Instruments for students consist of cognitive and non-cognitive instruments. The cognitive instrument used to measure students' ability in mathematics, science, and reading literacy. Meanwhile, non-cognitive instruments consist of a questionnaire on ICT literacy (ICT literacy), having social skills (global awareness), family and teacher support at school, student welfare, and financial literacy.

Financial literacy is a person's knowledge and understanding of financial concepts and ability to manage their finances to make effective decisions [8,9,10]. Students who have good abilities in financial literacy tend to have exemplary achievements in mathematics [11,12]. Meanwhile, many studies found that parental background affects student achievement [13,14]. They concluded that parental background significantly affects achievement. So in this study, students' ability in financial literacy and parents' educational background were used as explanatory variables, and math scores as response variables.

The sampling method used in AKSI is multistage probability sampling in which in the first stage, the districts sample are selected, then the school sample is determined at the second stage. At the third stage, the student sample is selected. Based on the sampling method, the data has a tiered data structure; students as level 1 are nested in the school as level 2. Based on this, the possibility of student achievement is also influenced by the quality of the school. The quality of the school in this study was seen based on the accreditation score that represents the ability of a school to provide educational services (Permendikbud Number 13 of 2018). So, in this study, the school's accreditation score was used as an independent variable at level 2.

Data with a tiered structure generally has similar characteristics in one group and has different diversity between groups. In this case, if the influence of school is neglected, multiple linear regression analysis cannot be used because it will violate the assumptions of independent residuals and homogeneity of variance. As consequence, it will result in incorrect residual estimators resulting in inaccurate conclusions [15,16,17]. Therefore, this study uses a stratified regression analysis technique to determine the effect of financial literacy and parents' educational background on student achievement in mathematics.

2. Material and methods

2.1. Data

The data was obtained from Pusmenjar and BAN-S/M. Student data comes from Pusmenjar with a total sample of 17282 9th grade students from 1925 junior high schools spread across all provinces in Indonesia. Meanwhile, the school data (accreditation score) comes from BAN-S/M. After the student and school data were combined, the total observations became 16500 students from 1804 schools. The variables used in this study consisted of student and school variables, which are presented in Table 1.

Table 1 Variables in the Study

Code	Variables	Measurement Scale
Response Variable		
Y	Mathematics AKSI Score	Interval
Independent Variables on Student Level		
X1	Gender	Binary
X2	Mother's last education	Interval
X3	Father's last education Interval	Interval
X4	Financial material acceptance index	Interval
X5	Index of tasks and activities on finance	Interval
X6	Index of acceptance of financial information	Interval
X7	Index of discussions on finance	Interval
X8	Index of financial use considerations	Interval

X9	Index of knowledge and ownership of financial tools Inte	Interval
X10	Financial management index Interval	Interval
X11	Index of financial measures Interval	Interval
Independent Variables on School Level		
Z	Accreditation Score	

Variables X4, X5, X6, X7, X8, X9, X10, and X11 are latent variables measured from several financial literacy questions. For example, the X11 variable consists of several questions about how confident students are in carrying out financial actions as follows: making money transfers, filling out bank's forms, understanding the information contained in the passbook, understanding sale and purchase agreements, monitoring changes in account balances, and planning expenses. The answers to these questions are in an ordinal scale with answer choices, namely, not at all sure, not too sure, sure, and very sure. Pusmenjar assigns scores to each answer and then processes them into a single value in the form of an index scaled from 0 to 1. The higher the score on the index, the better the students' ability in financial literacy. The same is done for the other variables.

2.2. Research Methodology

The stages of data analysis to be carried out are as follows:

1. Conduct descriptive data analysis on the explanatory variables at the level of students and schools in general.

2. Examine the effect of grouping (schools) on student achievement on math scores.

   a. Build a regular regression model without explanatory variables (null model). This model is used to see the average of the y-variable, the 2019 AKSI math score. The model can be written as follows:

$$y_i = \beta_0 + e_i$$

   b. Building a two-level regression model, a random intercept model without explanatory variables. This model is used to see the average of the y-variable with the effect of clustering. The model can be written as follows:

$$y_{ij} = \beta_0 + u_{0j} + e_{ij}$$

   c. Perform a chi-square test on the difference in the deviance values of the two models to see the significance of the school's influence. To test the significance of the difference in deviance values, the test statistics used are as follows:

$$LRT = -2\log\left(\frac{L_0}{L_1}\right)$$

where L_0 is the value of the probability function in the previous model and L_1 is the value of the probability function of the model being tested. The comparison of the probability values is chi-squared with degrees of freedom equal to the difference between the parameters of the two models [18].

   d. Calculate the expected value of intraclass correlation (ICC). ICC can be formulated as follows:

$$ICC = \frac{\sigma_{u0}^2}{\sigma_{uo}^2 + \sigma_e^2}$$

where σ_{u0}^2 and σ_e^2 are error terms variances on the group and individual levels [18].

3. Construct a two-level regression model, a random intercept model. The random intercept model is a form of multilevel regression model in which the intersection (intercept) of the y-axis is expressed in the form of random, not fixed as in ordinary linear regression. The multilevel representation of the random intercept model is expressed in the form, for the level-1 model:

$$Y_{ij} = \beta_{0j} + \sum_{p=1}^{p} \beta_p X_{pij} + e_{ij} \quad (1)$$

with:

Y_{ij} : response for the i-th unit at level-1 in the j-th unit at level-2

β_{0j} : random intercept for the j-th unit at level-2

β_p : fixed coefficient (fixed effects) for the explanatory variable p at level-1 $(X_1, X_2, \dots, X_P)$

X_{pij} : explanatory variable p at level-1 for the i-th unit at level-1 in the j-th unit at level-2

e_{ij} : residuals for the i-th unit at level-1 in the j-th unit at level-2 (level-1 residual), is assumed to be normally distributed, $\mathrm{N}(0, \sigma_e^2)$

For the level2 model, the expression is as follows:

$$\beta_{oj} = \beta_0 + u_{0j} \quad (2)$$

with

β_0 : fixed intercept, the overall mean on the variable y

u_{0j} : random effect (residuals) for the jth unit at level-2, assumed to be normally distributed, $\mathrm{N}(0, \sigma_{u_0}^2)$, u_{0j} and e_{ij} are assumed to be independent, cov $(\varepsilon_{ij}, u_{oj}) = 0$

Model (2) can be substituted into model (1) so that the two-level regression model with a random intercept becomes:

$$y_{ij} = \beta_0 + \sum_{p=1}^{p} \beta_p X_{pij} + u_{oj} + e_{ij} \quad (3)$$

1. Construct a two-level regression model, random coefficient model. The random coefficient model allows the regression lines for each level-2 unit to have a different slope. The multilevel representation of the random slope model is expressed in the form,

Level-1 model:

$$y_{ij} = \beta_{oj} + \sum_{p=1}^{P} \beta_{pj} X_{pij} + e_{ij} \quad (4)$$

with

Y_{ij} : response for the i-th unit at level-1 in the j-th unit at level-2

β_{0j} : random intercept for the jth unit at level-2

β_{pj} : random slope for the p-th explanatory variable at level-1 for the j-th unit level-2 $p = 1,2, \dots, P$

X_{pij} : the p-th explanatory variable at level-1 for the i-th unit at level-1 in the j-th unit at level-2

e_{ij} : the residual for the i-th unit at the level in the j-th unit at level-2 (level-1 residual), is assumed to be normally distributed, $\mathrm{N}(0, \sigma_e^2)$

Level-2 model:

$$\beta_{0j} = \gamma_{00} + \sum_{q=1}^{Q} \gamma_{0q} Z_{qj} + u_{0j} \tag{5}$$

$$\beta_{pj} = \gamma_{p0} + \sum_{q=1}^{Q} \gamma_{pq} Z_{qj} + u_{pj} \tag{6}$$

with

β_{0j} : random intercept for the jth unit at level-2

γ_{00} : intercept on the two-level regression equation which stated means

γ_{p0} : intercept in the two-level regression equations which states the means value of the slope (slope) of all groups

γ_{0q} : level-1 regression coefficient for the q-th explanatory variable at level-2 which predicts the variance at the level-1 regression equation intercept

γ_{pq} : regression coefficient for the q-th explanatory variable at level-2 which predicts the variance on the slope of the p-variable regression equation level-1

Z_{qj} : the q-th explanatory variable with $q = 1, 2, \ldots, Q$ for the jth unit at level-2

u_{0j} : random effect (remaining) for the jth unit at level-2, assumed to be normally distributed, $\mathrm{N}(0, \sigma^2_{u_0})$

u_{pj} : random effect for the j-th unit on the p-variable, is assumed to be normally distributed, $\mathrm{N}(0, \sigma^2_{u_p})$

The model in equation (5) and equation (6) can be substituted into equation (4) so that the two-level regression model with random intercept becomes:

$$Y_{ij} = \gamma_{00} + \sum_{p=1}^{P} \gamma_{p0} X_{pij} + \sum_{q=1}^{Q} \gamma_{0q} Z_{qj} + \sum_{p=1}^{P} \sum_{q=1}^{Q} \gamma_{pq} \beta_p X_{pij} Z_{qj} + \sum_{p=1}^{P} X_{pij} u_{qj} + u_{oj} + e_{ij}$$

2. Determine the best model by looking at the deviance value. Deviance can be formulated as follows:

$$D = -2 \log(L_1)$$

where L_1 is the value of the probability function. The smaller the deviance value, the better the model [18].

3. Results and discussion

3.1. Model without Explanatory Variables

The model without explanatory variables was used to determine whether school's influence on the mathematics scores achieved by students. The model without explanatory variables consists of a normal regression model with no explanatory variables (null model) and a random intercept model without explanatory variables (intercept only model). Null model is a model that describe the average math score of all students (Model 0, $y_i = \beta_0 + e_i$). Meanwhile, the intercept only model is a regression model which include the influence of schools which allows the average math score between schools to differ (Model 1, $y_{ij} = \beta_0 + u_{0j} + e_{ij}$). The two models were compared to see the effect of school-level diversity using the chi-square test on deviance values. The null hypothesis on the test is that there is no difference between schools (H0: σ_{u0}^2 = 0). Based on the chi-square test results on the difference in the deviance values of the two models (Table 2), the p-value is smaller than 5%. These results prove that there is an influence of school on mathematics scores achieved by students. It also proves that the multilevel regression method is suitable for use in this study.

Table 2 The results of the significance test of the difference in deviance values in Model 0 and 1

	No. of Parameter	Log Likelihood	*Deviance*	*Chisq*	Df	*p-value*
Model 0	2	-55372	110745			
Model 1	3	-54104	108208	2538	1	0.000

Intraclass correlation (ICC) was obtained by dividing the school level variance (σ_{u0}^2) by the total variance for individual and school levels ($\sigma_{u0}^2 + \sigma_e^2$). The variance at the student and at the school level (Table 12) are 12.98 and 35.66, respectively. Based on these values, the ICC value can be calculated as: 12.89 / (12.89+35.22) = 0.268. This indicates that 26.8% of the total diversity of math scores comes from the school level and the remaining 73.2% comes from the student level. In addition, the correlation of expectations of two randomly selected students who come from the same school is 0.268. It can be concluded that school diversity has a significant effect on students' achievement of mathematics scores.

3.2. Random Intercept Model

Multilevel regression model with random intercept is a regression model by including schools effects into the regression model. In this model, the intersection of the model with respect to the y-axis is expressed in the form of random instead of fixed as in ordinary linear regression. After determining that there is an effect of school influence on math scores which proves that the data has a tiered data structure, variables at the student level are added to the model.

Table 3 displays student achievement in mathematics which is influenced by mother's educational background (X2), father's educational background (X3), and students' ability in financial literacy which is explained by the index considering the use of finance (X8), financial management index (X10), and the index of financial measures (X11). Other variables at student level, gender (X1), financial acceptance intensity index (X4), financial tasks and activities index (X5), financial information acquisition index (X6), financial discussion index (X7), and knowledge and ownership index Finance (X9) has no significant effect on student achievement on the 2019 AKSI math score.

Table 3 The estimated value of the regression coefficient of the random intercept model

	Estimates	Standard error	t	*p-value*
Intercept	26.76	0.952	28.101	0.000
X1	0.172	0.097	1.770	0.045
X2	0.195	0.014	14.034	0.000
X3	0.076	0.013	5.607	0.000
X4	-1.670	0.910	-1.834	0.066
X5	0.612	1.121	0.547	0.584
X6	-1.743	1.780	-1.021	0.078
X7	0.968	1.096	0.884	0.376
X8	10.13	1.198	8.458	0.000
X9	1.887	1.105	1.708	0.087
X10	9.098	1.202	7.569	0.000
X11	7.679	1.006	7.630	0.000

After the variables X4, X5, X6, X7, and X9 were removed from the model, the intercepts and regression coefficients X2, X3, X8, X10, and X11 had a p-value of less than 5% (Table 4). These results prove that these variables have a significant effect on student achievement in the field of mathematics.

Tabel 4 Estimated value of the regression coefficient of the random intercept model (Model 2)

	Estimates	**Standard error**	**t**	***p-value***
Intercept	24.130	0.626	38.519	0.000
X2	0.197	0.013	14.340	0.000
X3	0.075	0.013	5.611	0.000
X8	10.670	1.158	8.073	0.000
X10	9.790	1.157	6.718	0.000
X11	7.460	9.846	6.857	0.000

The obtained random intercept model (Model 2) can be written as follows:

level-1

$$Y_{ij} = \beta_{oj} + 0.197\, X_{2ij} + 0.075\, X_{3ij} + 10.670\ X_{8ij} + 9.790\, X_{10ij} + 7.460\, X_{11ij} + e_{ij}$$

level-2

$$\beta_{oj} = 24.130 + u_{oj}$$

The level-1 and level-2 models are combined and become:

$$Y_{ij} = 24.130 + 0.197\, X_{2ij} + 0.075\, X_{3ij} + 10.670\ X_{8ij} + 9.790\, X_{10ij} + 7.460\, X_{11ij} + u_{oj} + e_{ij}$$

Based on Table 5, the random intercept model with the student level explanatory variable (Model 2) has a smaller deviance value than the random intercept model without the explanatory variable (Model 1). The difference in the deviance values of the two models is 717 which is spread chi-square with degrees of freedom of 5. The difference in values has a p-value of less than 5%. This proves that Model 2 is significantly better than Model 1.

Table 5 The results of the significance test of the difference in deviance values in Models 1 and 2

	No. of Parameter	**Log Likelihood**	***Deviance***	***Chisq***	**Df**	***p-value***
Model 1	3	-54104	108208			
Model 2	8	-53746	107491	717	5	0.000

The addition of explanatory variables at the student level into the model causes a decrease in diversity at the student and school levels. Table 12 shows that the variance at the student level (σ_e^2) was decreased from 35.22 (Model 1) to 34.56 (Model 2). In addition, the variance at the school level (σ_{u0}^2) was also decreased from 12.89 (Model 1) to 9.343 (Model 2). Although the variables used are variables at the student level, these variables have different effects on student achievement at each school. For example, students who often take financial actions (X11) tend to have higher math scores than students who rarely take financial actions. The average math score at schools where most students often take financial actions will be higher than schools with the majority of students taking financial actions less often.

To calculate the variance that can be explained in the model or the coefficient of determination (R^2) at the student level, the Model 2 variance is reduced by the Model 1 variance and then divided by the Model 1 variance. $(35.22 - 34.56)/35.22 = 0.0187$. About 1.87% of the total variability of mathematics scores at the student level is explained by the variables X2, X3, X8, X10, and X11. To calculate the variance described at the school level, you can use the same formula, (12.89-9.343)/12.89 = 0.275. That is, variables explain 27.5% of the variability of mathematics scores at the school level at the student level (X2, X3, X8, X10, and X11).

Next, the explanatory variables at the school level are included in the model. School characteristics described by school accreditation scores (Z1) were used to predict differences in intercepts between schools. Based on Table 6, school accreditation scores have a very significant influence on student achievement in mathematics. Students studying at schools with high accreditation scores tend to have higher math scores than those with low accreditation scores. This proves that student achievement is influenced by the characteristics of the school, namely the accreditation score. School accreditation reflects how well the quality of the school is based on assessment aspects such as qualified educators, conformity of teaching materials with the applicable curriculum, room conditions that are in accordance with standards, appropriate and adequate study group capacity, availability of librarians and laboratory technicians, ownership of fund management reports, and so on (BAN-S/M 2018).

Table 6 The estimated value of the regression coefficient of the random intercept model with the school level variable (Model 3)

	Estimates	**Standard error**	**t**	**p-value**
Intercept	8.994	1.176	7.646	0.000
X2	0.181	0.013	13.181	0.000
X3	0.059	0.013	4.418	0.000
X8	10.08	1.155	8.723	0.000
X10	9.516	1.154	8.249	0.000
X11	7.209	0.981	7.343	0.000
Z1	0.181	0.012	14.796	0.000

The random intercept model with school-level independent variables (Model 3) obtained can be written as follows:

level-1

$$Y_{ij} = \beta_{oj} + 0.181\, X_{2ij} + 0.059\, X_{3ij} + 10.080\ X_{8ij} + 9.516\, X_{10ij} + 7.209\, X_{11ij} + e_{ij}$$

level-2

$$\beta_{oj} = 8.994 + 0.181\, Z_1 + u_{oj}$$

Level-1 and Level-2 model are combined to have the following expression:

$$Y_{ij} = 8.994 + 0.181\, X_{2ij} + 0.059\, X_{3ij} + 10.080\ X_{8ij} + 9.516\, X_{10ij} + 7.209\, X_{11ij} + 0.181\, Z_1 + u_{oj} + e_{ij}$$

Table 7 shows that the addition of school accreditation scores into the model has reduced the deviance value to 107283. Based on the Chi-square test of the difference in deviance values with the previous model, Model 3 is significantly better than Model 2.

Table 7 Testing the difference in deviance values between Model 2 and Model 3

	No. of Parameter	Log Likelihood	*Deviance*	*Chisq*	df	*p-value*
Model 2	8	-53746	107491			
Model 3	9	-53641	107283	208	1	0.000

3.3. Random coefficient model

The random coefficient model (Model 4) is a model for analyzing the relationship between explanatory variables and student achievement in each school. This model is used to determine whether the effect of the explanatory variables at the student level on student achievement in mathematics is different in each school. The selection of variables X2 and X3 which are random coefficients is based on the results of the best model selection. The estimated value of the regression coefficient on the random coefficient model of the variables X2 and X3 can be seen in Table 8.

Table 8 Estimated value of regression coefficient on Model 4

	Estimates	Standard Error	t	*P-value*
Intercept	10.003	1.142	8.786	0.000
X2	0.182	0.014	12.909	0.000
X3	0.056	0.013	4.162	0.000
X8	9.972	1.155	8.637	0.000
X10	9.528	1.151	8.278	0.000
X11	7.055	0.981	7.189	0.000
Z1	0.170	0.0181	14.413	0.000

The random coefficient model (Model 4) obtained can be written as follows:

level-1

$$Y_{ij} \quad = \quad \beta_{oj} + \beta_{2j}\, X_{2ij} + \beta_{3j}\, X_{3ij} + 10.670\ X_{8ij} + 9.528\, X_{10ij} + 7.055\, X_{11ij} + e_{ij}$$

level-2

$$\beta_{oj} \quad = \quad 10.003 + 0.170\, Z_{1j} + u_{oj}$$

$$\beta_{2j} \quad = \quad 0.182 + u_{2j}$$

$$\beta_{3j} \quad = \quad 0.056 + u_{3j}$$

Model on level-1 and level-2 are combined to have the following equation:

$$Y_{ij} \quad = \quad 10.003 + 0.182\, X_{2ij} + 0.056\, X_{3ij} + 9.972\ X_{8ij} + 9.528\, X_{10ij} + 7.055\, X_{11ij} + 0.170\, Z_1 + u_{oj} + u_{2j} X_{2ij} + u_{3j} X_{3ij} + e_{ij}$$

Once the variance of X2 and X3 is entered into the model, the deviance value has decreased to 107237 compared to the previous model. The difference in the deviance value of this node with the previous model is 46 with a p-value < 0.000 in the Chi-square test (Table 9). This shows that Model 4 is better than Model 3. This means that the effect of X2 (mother's educational background) and X3 (father's educational background) on student achievement in mathematics (Y) is different between schools.

Table 9 Testing the difference in deviance values between Model 3 and Model 4

	Number of Parameter	**Log Likelihood**	***Deviance***	***Chisq***	**df**	***P-value***
Model 3	9	-53641	107283			
Model 4	14	-53619	107237	46	5	0.000

The last step of the multilevel model is to find out whether there is an interaction between the student level explanatory variables that have random coefficients (X2 and X3) on the school level explanatory variables (Z1). Table 10 shows that there is an interaction between X2 or X3 with Z1. With the presence of these interaction components, all the estimated regression line parameters change. In addition, the deviance also decreased significantly when compared to the previous model (Table 11). This shows that the random coefficient model with interaction (Model 5) is the best. In this model, it is known that the influence of the mother's educational background (X2) and father's educational background (X3) on student achievement in mathematics (Y) is influenced by school accreditation scores (Z1).

Table 10 Estimated value of regression coefficient on Model 5

	Estimates	**Standard Error**	**t**	**P-value**
Intercept	19.610	2.504	7.832	0.000
X2	-0.252	0.184	-1.365	0.172
X3	-0.574	0.179	-3.210	0.000
X8	9.951	1.155	8.619	0.000
X10	9.542	1.151	8.290	0.000
X11	7.027	0.981	7.160	0.000
Z1	0.061	0.027	2.192	0.000
X2:Z1	0.004	0.002	2.363	0.000
X3:Z1	0.007	0.002	3.539	0.000

Table 11 Testing the difference in deviance values between Model 4 and Model 5

	Number of Parameter	**Log Likelihood**	***Deviance***	***Chisq***	**df**	***P-value***
Model 4	14	-53619	107237			
Model 5	16	-53612	107219	18	2	0.000

The random coefficient model with interaction (Model 5) obtained can be written as follows:

level-1

$$Y_{ij} = \beta_{oj} + \beta_{2j} X_{2ij} + \beta_{3j} X_{3ij} + 9.951\, X_{8ij} + 9.542\, X_{10ij} + 7.027\, X_{11ij} + e_{ij}$$

level-2

$$\beta_{oj} = 19.610 + 0.061\, Z_{1j} + u_{oj}$$

$$\beta_{2j} = -0.252 + 0.004\, Z_{1j} + u_{2j}$$

$$\beta_{3j} = -0.574 + 0.007\, Z_{1j} + u_{3j}$$

The models at level-1 and level-2 are combined into:

$$\begin{aligned} Y_{ij} = {} & 19.610 - 0.252\, X_{2ij} - 0.574\, X_{3ij} + 9.951\, X_{8ij} + 9.542\, X_{10ij} + \\ & 7.027\, X_{11ij} + 0.061\, Z_{1j} + 0.004\, X_{2ij}\, Z_{1j} + 0.007\, X_{3ij}\, Z_{1j} + u_{oj} + \\ & u_{2j}\, X_{2ij} + u_{3j}\, X_{3ij} + e_{ij} \end{aligned}$$

Based on this model, it can be seen that students' abilities in financial literacy, such as students' attitudes before buying goods (X8), ability to manage finances (X10), and intensity in taking actions regarding finances (X11) have a significant influence on student achievement. Students who often compare prices in several stores and wait for product prices to drop before buying an item (X8) tend to have higher math scores than students who rarely do this. In addition, students who like to discuss finances, manage their finances, and want to run their own business (X10) tend to have high math scores. In this study, it was also found that students often took actions related to financing (X11) such as transferring money, filling out forms at the bank, understanding the information contained in the passbook, understanding sale and purchase agreements, monitoring changes in account balances, and planning expenses. taking into account the amount of money they have also tend to have higher math scores. This means that students who are financially literate will have good abilities in the field of mathematics.

Table 12 Comparison of the estimated results of regression coefficients and deviance values in all models

	Model 0	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Fixed effects						
Intersep	39.53	39.47	24.13	8.994	10.9	19.610
X2			0.197	0.181	0.184	-0.252
X3			0.075	0.059	0.056	-0.574
X8			10.67	10.008	9.683	9.951
X10			9.794	9.516	8.607	9.542
X11			7.460	7.209	6.343	7.027
Z1				0.181	0.170	0.061
X2:Z1						0.004
X3:Z1						0.007
Random effects						
σ_e^2	48.134	35.22	34.560	34.525	34.392	34.407
σ_{u0}^2		12.89	9.343	7.999	4.172	3.792
σ_{u2}^2					0.014	0.013
σ_{u3}^2					0.004	0.004
Fit						
Deviance	110745	108208	107491	107283	107237	107219

School quality which is represented by school accreditation score (Z1) has a significant effect on student achievement. Schools that have high accreditation scores have students who tend to have high average math scores as well. In addition, the influence of parents' educational background (X2 and X3) on student achievement has a different effect between schools. The difference in the effect of parents' educational background on student achievement is influenced by school accreditation scores.

Table 12 compares several aspects of all the models carried out in this study. In Model 2, it is obtained that 27.5% of the variance of intercepts describes the difference in the average math scores between schools which can be explained by the variables X2, X3, X8, X10, and X11. So the school accreditation score (Z1) contributes 10.44% to the diversity of student achievement at the school level. By adding school accreditation scores to the model, the variance of variance at the school level decreases to 7.99. The same method can be used to calculate the variance described by the variables X2, X3, X8, X10, and Z1, namely (12.89-7.999)/12.89= 0.3794. The diversity of student achievement in Mathematics can be explained by the variables X2, X3, X8, X10, X11, and Z1 of 37.94% at the school level. Furthermore, the variance at the student level also decreased to 34,525. The coefficient of determination at the student level is 0.0197 ((35.22-34.525)/35.22)). This means that 1.97% of the diversity of student achievement in mathematics at the student level is explained by the variables X2, X3, X8, X10, X11, and Z1. The variables X2, X3, X8, X10, and X11 explain 1.87% of the total diversity at the student level (Model 2), so the school accreditation score (Z1) contributes 0.1% to the diversity of student achievement at the school level.

4. Conclusion

The random coefficient model with the interaction of parental background (X3 and X3) and school accreditation score (Z1) is the best multilevel regression model in this study. School quality as explained by the accreditation score has a significant effect on student achievement in mathematics at AKSI 2019. Schools that have high accreditation tend to have higher average math scores than schools with low accreditation. Parents' educational background (X2 and X3) and financial literacy (X8, X10, and X11) also significantly affect the achievement of mathematics scores achieved by students. The higher the level of parental education and students' knowledge of financial literacy, the higher the achievement in mathematics. However, the influence of parents' educational background on student achievement differs between schools. The difference in influence is caused by the accreditation score at each school.

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