Hierarchical linear model to examine determinants of students’ mathematics performance

Getinet Seifu Walde*
School of Mathematics and Statistics, Beijing Institute of Technology, Beijing, China
Corresponding author e-mail: getinetseifu@yahoo.com

Abstract. This paper identifies the determinants of quality of general secondary school mathematics education by applying two-level, hierarchical linear models. The research was conducted on 361 general secondary school students of Ethiopia. A multi-stage random stratified method of sampling was used to select students and schools. Questionnaires and students’ mathematics score used for data collection and a hierarchical linear model technique employed for data analysis. The study found out that family support, motivation, participation, cooperation between students and teachers has a direct effect on students’ mathematics performance. On the other side, feedback given to all students in the classroom is negatively affecting students’ achievement. However, there is no gender gap in achievement teachers’ motivation and their cooperation with students has less effect on students’ mathematics achievement. The interaction between the student’s considering mathematics is a difficult subject with teacher’s ability to enable all students to participate equally in the classroom is the most significant influential predictor on student’s mathematics performance.

1. Introduction
Hierarchical linear model (HLM) is one of a statistical model used to analyze a nested data. It is applied when the predictor variables organized at more than one level; e.g., students in the same section share variance due to their common teacher and the same teaching room [15]. Hence it allows investigating the relationship within a given hierarchical level and the relationship across levels at the same time. Due to this shared variance and standard errors HLM introduced.

Student’s academic performance is associated with quality of education [2]. Similarly, Fenstermacher and Richardson [3], also mentioned, the quality of education is the teaching that produces learning. Thus, teaching quality in practice depends on activities that improve student performance. In this study, the researcher used two-level hierarchical data structures for the students score in mathematics variable: the structure in which the lower-level units (student) used as individuals, and the higher-level units (classroom) used as groups adopted in this study to examine how students and classrooms characteristics influence student’s mathematics performance.

In this study, we intended to examine the degree to which factors related to students and classroom determine students’ mathematics education performance using HLM in general secondary school (GSS) of Ilu Ababor zone, Ethiopia. In Ethiopia GSS, Hunde and Tegegn [5] indicated that student-centered method of teaching mathematics not implemented properly. Mathematics teachers’ attitude toward teaching mathematics is also low [1]. However, as of researchers knowledge, there is no research evidence indicated that these are determinants of student’s performance in mathematics.
Hence, by examining the determinants of students’ mathematics education performance, this paper bridges the gap that has existed due to a lack of research evidence on the determinants of students’ mathematics education performance in Ethiopia. This study results will be also useful for administrators and teachers to guide them properly.

2. Literature review

At the lower-level of the hierarchy; gender, having family support on their mathematics achievement, the interest of students toward learning mathematics and students’ perceived difficulty of mathematics are variables identified as level-1. Students’ perception about their school affects their performance, motivation, feelings toward study and effort [10, 12]. Student’s interest to participate in activities for their satisfaction is an important issue for the high quality of education [9].

Students Self-efficacy also exerts a positive effect on their mathematics achievement [6]. Using exploratory factor analysis and Pearson correlation [3] concluded self-efficacy has not significant with academic achievement. In this study, researchers used a hierarchical linear model to determine its effect.

Related to gender gaps, boys outperform than girls in both mathematics and science [10, 12]. In line with this, a study in Florida by Winters et al. [14] found that GSS students benefit more from the assignment of a female mathematics teacher. Family support also plays a vital role in the academic achievement of their children’s. Muhammad et al. [7] mentioned that children’s family participation in their children’s academic study had a direct effect on their success and enhanced their academic achievements.

Variables at the lower level are nested within higher level groups and share the impact of higher level variables. At the higher level; give feedback on homework to the whole class in the classroom, interest of teachers to teach, teacher’s ability to encourage all students to participate equally and cooperation between teachers with students are level-2 variables. In classroom level teachers plays a great role to influence student’s ways of learning [13]. Actively involving students in the classroom and giving feedback after assessments are other factors related to educational quality [4].

2.1. Hierarchical linear model development

In this study, two-level hierarchical linear model developed. The first model represents the relationships among the level-1 variables, which nested within classrooms. The second model includes the influence of classroom-level variables. The outcome variable, students’ mathematics score, is also measured at level-1. The notation employed by Raudenbush & Bryk [8] for two-level models used. These notations can be presented either by the level of analysis or in a single equation.

2.1.1. Unconditional (null) Model. It is used to establish a baseline model from which consequent models compared, and to confine the degree to which variance at level-1 depends upon level-2. Two-level HLM with no predictor variables is displayed by the level analysis (see eq. 1 & 2) and in a single equation (mixed model) (see eq. 3) as:

\[ \text{Level } - 1: \ y_{ij} = \beta_{0j} + r_{ij} \]  \hspace{1cm} (1)

\[ \text{Level } - 2: \ \beta_{0j} = \gamma_{00} + u_{0j} \]  \hspace{1cm} (2)

The combined model becomes

\[ y_{ij} = \gamma_{00} + u_{0j} + r_{ij} \]  \hspace{1cm} (3)

The indices i, j denote students and classrooms where there is i = 1, 2, ..., n_j; student nested within j = 1, 2, ..., J; classroom. The outcome, y_{ij} represent mathematics score for student i nested in classroom j and equal to a level-1 intercept, \beta_{0j}, and level-1 random effect, r_{ij}. At level-2, \beta_{0j} is set as the outcome in a new regression equation with its intercept, \gamma_{00}, and its random effect, u_{0j}. Where we assume r_{ij} \sim N(0, \delta^2) and u_{0j} \sim N(0, \tau_{00}) and \delta^2 - refer to level-1 variance and \tau_{00}- refer to level-2 variance. The dependence at classroom level calculated by the intraclass correlation coefficient (ICC), defined as:

\[ \text{ICC} = \frac{\tau_{00}}{\delta^2 + \tau_{00}} \]  \hspace{1cm} (4)
2.1.2. Level-1 model (student-level model). A level-1 model could be developed to model the student’s mathematics score as a function of level-1 variables. In this model, we represent the outcome for student \( i \) within classroom \( j \) as:

\[
y_{ij} = \beta_{0j} + \sum_{q=1}^{Q} \beta_{qj} X_{qij} + r_{ij}
\]  

\( \cdots (5) \)

The classroom model becomes

\[
\begin{cases}
\beta_{0j} = \gamma_{00} + u_{0j} \\
\beta_{1j} = \gamma_{10} + u_{1j} \\
\vdots \\
\beta_{qj} = \gamma_{q0} + u_{qj}
\end{cases}
\]  

\( \cdots (6) \)

Hence, the combined model becomes

\[
y_{ij} = \gamma_{00} + \sum_{q=1}^{Q} \gamma_{q0} X_{qij} + \sum_{q=1}^{Q} u_{qj} X_{qij} + u_{0j} + r_{ij}
\]  

\( \cdots (7) \)

Where: \( \beta_{qj} \), (\( q = 0, 1, \ldots, Q \)) is student level regression coefficient; \( X_{qij} \) is student level variable \( q \) for student \( i \) in classroom \( j \); \( y_{qj}, (q = 0, 1, \ldots, Q) \) is mean of the slopes across classrooms. The effect of student-level variables on the outcome variable calculated through the variance, \( r^2 \), defined as:

\[
r^2 = \frac{\delta^2_{null} - \delta^2_{random}}{\delta^2_{null}}
\]  

\( \cdots (8) \)

Where: \( \delta^2_{null} \) is a value obtained in unconditional model testing, and \( \delta^2_{random} \) is the value of the level-1 model.

2.1.3. Level-2 model (school-level model). As stated by Raudenbush & Bryk, [8]; Woltman et al. [15] intercept (\( \beta_{0j} \)) and slopes (\( \beta_{qj} \)) in the level-1 are used as outcome variables at level-2. They are also related to each of the level-2 variables as:

\[
\begin{cases}
\beta_{0j} = \gamma_{00} + \gamma_{01} W_{1j} + \gamma_{02} W_{2j} + \cdots + \gamma_{0s} W_{sj} + u_{0j} \\
\beta_{1j} = \gamma_{10} + \gamma_{11} W_{1j} + \gamma_{12} W_{2j} + \cdots + \gamma_{1s} W_{sj} + u_{1j} \\
\vdots \\
\beta_{qj} = \gamma_{q0} + \gamma_{q1} W_{1j} + \gamma_{q2} W_{2j} + \cdots + \gamma_{qs} W_{sj} + u_{qj}
\end{cases}
\]  

\( \cdots (9) \)

Combining the classroom-level model (eq. 9) and student level model (eq. 5) yields a mixed model:

\[
y_{ij} = y_{00} + \sum_{q=1}^{Q} \gamma_{q0} X_{qij} + \sum_{s=1}^{S} \sum_{q=1}^{Q} \gamma_{qs} X_{qij} W_{sj} + \sum_{q=1}^{Q} u_{qj} X_{qij} + u_{0j} + r_{ij}
\]  

\( \cdots (10) \)

Where: \( \gamma_{qs} \), is the cross-level interactions involving each student-level variables with classroom-level variables; \( y_{0s} \), is the main effect of level-2 predictors; \( W_{sj} \) is the classroom level predictor \( s \) of classroom \( j \).

3. Design of the study

All Cross-sectional research design employed with a quantitative research approach. First, six schools from Ilu Ababor zone were selected using a multi-stage random stratified sampling method. Then 32 classrooms selected from the six schools randomly.

3.1. Participants and data collection instruments

The target population for this study covered all grade nine students at government GSS of Ilu Ababor zone, Ethiopia. Based on the proportion of students out of 5,876 students a total of 361 students were randomly selected using determinations of sample size formula. Questionnaires were used to collect
data from students. Document analysis was also used to gather students’ mathematics score at the end of the second semester of 2016 academic year.

3.2. Data analysis
In this study quantitative statistical analysis procedures, and two-level HLM used to analyze the data. The questionnaires items were rated on Likert scale having five degrees of agreements ranging from 1 = strongly disagree, to 5 = strongly agree in which 3.0 is the average mean scales. Dummy coding also used for Gender.

4. Results
The assumptions of HLM which is examined using the output found in the residual files met. The dependent variable is students’ mathematics score out of 100%.

4.1. Unconditional (null) model
The first model tests the existence of differences at group level on the student’s mathematics scores (MATHSCOR), and verifies the necessity of the model. Using the dialogue box, MATHSCOR entered into the model as an “outcome variable.” The generated output is shown in table 1, and the summary of the null model in a single equation (Mixed Model) as in Eq. 3 is:

\[ MATHSCOR_{ij} = \gamma_{00} + u_{0j} + r_{ij} \]

The intraclass correlation coefficient (Eq. 4) was calculated to measure the proportion of variance in student’s score explained by the grouping structure of the hierarchical model that is between classrooms (level-2) using \( \delta^2 = 65.77 \) and \( \tau_{00} = 6.08 \), which obtained from the null model:

\[ ICC = \frac{\tau_{00}}{\delta^2 + \tau_{00}} = \frac{6.08}{65.77 + 6.08} = 0.085 \]

Table 1. Final estimation of fixed and random effects of the null model

| Fixed Effect | Coefficient | Std Error | T-ratio | Approx. df | P-value |
|--------------|-------------|-----------|---------|------------|---------|
| For INTRCPT1, \( \beta_0 \) | INTRCPT2, \( \gamma_{00} \) | 57.758854 | 0.610598 | 94.594 | 31 | 0.000 |

| Random Effect | Std. Dev. | Variance Component | df | Chi-square | P-value |
|---------------|----------|--------------------|----|------------|---------|
| INTRCPT1, \( u_0 \) | 2.46616 | 6.08193 | 31 | 63.33730 | 0.001 |
| level-1, \( r \) | 8.11014 | 65.77437 | |

Deviance = 2556.688393 with number of estimated parameters = 2

4.2. Random Intercepts Model
The second model measures the association of student-level variables with students mathematics score. The generated output is shown in table 2, and the summary of the Level-1 model in a single equation as in Eq. 3 is:

\[ MATHSCOR_{ij} = \gamma_{00} + \gamma_{10} \ast FEMALE_{ij} + \gamma_{20} \ast FAMSUPO_{ij} + \gamma_{30} \ast SINTER_{ij} + \gamma_{40} \ast MATHDIF_{ij} + u_{0j} + u_{1j} \ast FEMALE_{ij} + u_{2j} \ast FAMSUPO_{ij} + u_{3j} \ast SINTER_{ij} + u_{4j} \ast MATHDIF_{ij} + r_{ij} \]

The connection between the level-1 variables and student’s mathematics score is estimated using the significance of regression coefficients. The effect of level-1 predictor variables on student’s mathematics score (variance) (using Eq. 8):

\[ r^2 = \frac{\delta^2_{null} - \delta^2_{random}}{\delta^2_{null}} = \frac{65.77 - 17.18}{65.77} = 0.7388 \]

The value indicates that level-1 predictor variables explain 73.88% of the variance in student’s mathematics score.
Table 2. The result from fixed and random effects of level-1 model

| Fixed Effect | Coefficient | Std Error | T-ratio | Approx. df | P-value |
|--------------|-------------|-----------|---------|------------|---------|
| For INTRCPT1, $\beta_0$ | 57.745283 | 0.602215 | 95.888 | 31 | 0.000 |
| INTRCPT2, $\gamma_{00}$ | -1.184989 | 0.726112 | -1.632 | 31 | 0.113 |
| For FEMALE slope, $\beta_1$ | 4.323240 | 0.566767 | 7.628 | 31 | 0.000 |
| For FAMSUPO slope, $\beta_2$ | 4.723904 | 0.381258 | 12.390 | 31 | 0.000 |
| For SINTER slope, $\beta_3$ | -2.951251 | 0.574449 | -5.138 | 31 | 0.000 |

Random Effect

| Std. Dev. | Variance Component | df | Chi-square | P-value |
|-----------|--------------------|----|------------|---------|
| INTRCPT1, $u_0$ | 3.17407 | 10.07471 | 22 | 208.46281 | 0.000 |
| FEMALE slope, $u_1$ | 2.52664 | 5.09242 | 22 | 26.85675 | 0.216 |
| FAMSUPO slope, $u_2$ | 1.58907 | 2.52515 | 22 | 31.90768 | 0.079 |
| SINTER slope, $u_3$ | 1.03081 | 1.06257 | 22 | 26.79960 | 0.219 |
| MATHDIF slope, $u_4$ | 1.93323 | 3.73738 | 22 | 24.60417 | 0.316 |
| level-1, $r$ | 4.14517 | 17.18245 | |

Deviance = 2148.244703 with parameters = 16

4.3. Means as Outcomes Model

The third model is used to test the association among classroom variables and the student’s mathematics score. The results are given in table 3 and the summary of the level-2 model in a single equation is:

$$MATHSCOR_{ij} = \gamma_{00} + \gamma_{01} \ast FEEDB_{ij} + \gamma_{02} \ast TINTER_{ij} + \gamma_{03} \ast PARTICP_{ij} + \gamma_{04} \ast COOPR_{ij} + U_{0j} + r_{ij}$$

Table 3. The results from fixed and random effects of level-2 model

| Fixed Effect | Coefficient | Std Error | T-ratio | Approx. df | P-value |
|--------------|-------------|-----------|---------|------------|---------|
| For INTRCPT1, $\beta_0$ | 57.771477 | 0.508856 | 113.532 | 27 | 0.000 |
| INTRCPT2, $\gamma_{00}$ | -2.009678 | 0.838767 | -2.396 | 27 | 0.024 |
| FEEDB, $\gamma_{01}$ | 1.229678 | 0.838752 | 1.466 | 27 | 0.154 |
| TINTER, $\gamma_{02}$ | 4.004604 | 1.325490 | 3.021 | 27 | 0.005 |
| PARTICP, $\gamma_{03}$ | 1.251291 | 0.724067 | 1.728 | 27 | 0.095 |
| COOPR, $\gamma_{04}$ | 1.56202 | 10.07471 | 22 | 208.46281 | 0.000 |
| level-1, $r$ | 1.251291 | 0.724067 | 1.728 | 27 | 0.095 |

Random Effect

| Std. Dev. | Variance Component | df | Chi-square | P-value |
|-----------|--------------------|----|------------|---------|
| INTRCPT1, $u_0$ | 2.43991 | 2.43991 | 27 | 37.78427 | 0.081 |
| level-1, $r$ | 8.11042 | 65.77888 | |

Deviance = 2536.045152 with parameters = 2

The effect of level-2 predictor variables on student’s mathematics score can be computed using:

$$r^2 = \frac{\tau^2_{null} - \tau^2_{mean}}{\tau^2_{null}} = \frac{6.08 - 2.44}{6.08} = 0.5987$$

Where: $\tau^2_{null}$ and $\tau^2_{random}$ are the $\tau_{00}$ value obtained in the first and this model respectively.

4.4. Random Intercepts and Slopes Model

The last model tests the interaction between the two levels variables. This is used to identify the main effects of all predictor variables on students mathematics score. Summary of Level-1 & 2 interaction model specified in a hierarchical format as in Eq. 1 and Eq. 2 is:

Level-1 Model

$$MATHSCOR_{ij} = \beta_{0j} + \beta_{1j} \ast (FEMALE_{ij}) + \beta_{2j} \ast (FAMSUPO_{ij}) + \beta_{3j} \ast (SINTER_{ij}) + \beta_{4j} \ast (MATHDIF_{ij}) + r_{ij}$$

Level-2 Model
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\[ \beta_{ij} = \gamma_{i0} + \gamma_{i1} \times (FEEDB_i) + \gamma_{i2} \times (TINTER_i) + \gamma_{i3} \times (PARTICP_i) + \gamma_{i4} \times (COOPR_i) + U_{ij} \]

This is the only model in which we have cross-level interactions between the classroom-level variables and student-level variables. We can see that in the hierarchical format, level-2 predictors have slope coefficients within each of the five equations. This relates the interaction terms in the mixed model for level-2 predictors by level-1 predictors.

**Table 4.** The output from fixed and random effects of level 1 & 2 interaction model

| Fixed Effect | Coefficient | Std Error | T-ratio | Approx. df | P-value |
|--------------|-------------|-----------|---------|------------|---------|
| For INTRCPT1, \(\beta_0\) | \(\gamma_{00}\) | 57.749610 | 0.500867 | 115.299 | 27 | 0.000 |
| \(\gamma_{01}\) | -2.014378 | 0.824402 | -2.443 | 27 | 0.021 |
| \(\gamma_{02}\) | 2.455710 | 1.302424 | 3.023 | 27 | 0.005 |
| \(\gamma_{03}\) | 1.224996 | 0.712652 | 1.719 | 27 | 0.097 |
| For INTRCPT2, \(\gamma_{20}\) | 1.241139 | 0.824423 | 1.505 | 27 | 0.144 |
| \(\gamma_{21}\) | 3.936170 | 1.302424 | 3.023 | 27 | 0.005 |
| \(\gamma_{22}\) | 1.224996 | 0.712652 | 1.719 | 27 | 0.097 |
| For FEMALE slope, \(\beta_1\) | \(\gamma_{10}\) | -1.051662 | 0.800247 | -1.314 | 27 | 0.200 |
| \(\gamma_{11}\) | -1.81938 | 1.283951 | -0.921 | 27 | 0.365 |
| \(\gamma_{12}\) | 1.50178 | 1.278711 | 1.134 | 27 | 0.267 |
| \(\gamma_{13}\) | 2.456373 | 2.067715 | 1.188 | 27 | 0.245 |
| \(\gamma_{14}\) | -1.106680 | 1.135893 | -0.969 | 27 | 0.341 |
| For FEEDB slope, \(\beta_2\) | \(\gamma_{20}\) | 4.253354 | 0.617035 | 6.893 | 27 | 0.000 |
| \(\gamma_{21}\) | 0.228709 | 1.033051 | 0.221 | 27 | 0.826 |
| \(\gamma_{22}\) | 0.175653 | 1.016263 | 0.173 | 27 | 0.864 |
| \(\gamma_{23}\) | 0.427653 | 1.635101 | 0.262 | 27 | 0.796 |
| \(\gamma_{24}\) | -0.692552 | 0.849870 | -0.815 | 27 | 0.422 |
| For PARTICP slope, \(\beta_3\) | \(\gamma_{30}\) | 1.99555 | 3.98224 | 0.503514 | 0.715540 | 0.704 | 27 | 0.488 |
| \(\gamma_{31}\) | -0.445343 | 0.541871 | -0.822 | 27 | 0.418 |
| \(\gamma_{32}\) | -0.840002 | 1.132987 | -0.822 | 27 | 0.418 |
| \(\gamma_{33}\) | 1.375801 | 0.889026 | 1.548 | 27 | 0.133 |
| \(\gamma_{34}\) | -2.941425 | 1.369737 | -2.147 | 27 | 0.041 |
| \(\gamma_{35}\) | -0.290100 | 0.712847 | -0.407 | 27 | 0.687 |
| \(\gamma_{36}\) | 0.503514 | 0.715540 | 0.704 | 27 | 0.488 |
| \(\gamma_{37}\) | -0.445343 | 0.541871 | -0.822 | 27 | 0.418 |
| \(\gamma_{38}\) | -2.941425 | 1.369737 | -2.147 | 27 | 0.041 |
| \(\gamma_{39}\) | 1.99555 | 3.98224 | 0.503514 | 0.715540 | 0.704 | 27 | 0.488 |
| \(\gamma_{40}\) | 0.290100 | 0.712847 | -0.407 | 27 | 0.687 |
| \(\gamma_{41}\) | -0.445343 | 0.541871 | -0.822 | 27 | 0.418 |
| \(\gamma_{42}\) | -2.941425 | 1.369737 | -2.147 | 27 | 0.041 |
| \(\gamma_{43}\) | 1.99555 | 3.98224 | 0.503514 | 0.715540 | 0.704 | 27 | 0.488 |

5. Discussion

The ICC result from the first model (null model) indicates that 8.5% of the variation in student’s mathematics scores is at the higher level and 91.5% is within students. This shows that student’s mathematics score is associated highly with students characteristics.
The second model, which explains 73.88% of the variance in student’s mathematics score, was tested using regression coefficients of students level predictor variables. Gender (being a female) is negatively related to student’s mathematics scores but not statistically significant ($b = -1.18, p > 0.05$). Students who have family support on their mathematics achievement were likely to outperform their counterparts, and an increase of one unit in family support corresponds with a children’s mathematics score increase by 4.32, holding other variables constant ($b = 4.32, p < .001$). This regression coefficient is statistically significant and consistent with the finding of Muhammad et al. [7].

A unit increase in student’s interest is the cause of an increase in students’ mathematics performance by 4.72, holding other predictors constant ($b = 4.72, p < .001$). This regression coefficient is statistically significant. A unit increase in student’s consideration of mathematics as the difficult subject was associated with a decrease of student’s mathematics performance by 2.95, holding other factors as constant ($b = -2.95, p < .001$). This relationship is statistically significant at 5% level of significance and inconsistent with the result of Baharin, Othman & Azizan [2].

From the third model, the regression coefficient relating giving feedback on homework to whole students in the classroom to student’s mathematics score was negative and significant ($b = -2.01, p = .024$). Student’s mathematics score was higher in the classroom where a teacher gives feedback to individual students than the whole students. The regression coefficient of teacher’s interest to teach was positive but statistically not significant ($b = 1.23, p > .05$). An increase of a unit in teacher’s ability to enable all students to participate equally in the classroom is statistically significant and associated with an increase of student’s mathematics score by 4, holding other variables constant ($b = 4.00, p = .005$). On the other hand cooperation between teacher and students is not significantly associated with it ($b = 1.25, p > .05$).

Finally, from the random intercepts and slopes model, which tests the influential predictor variables, the interaction between students considering mathematics is a difficult subject with teacher’s ability to enable all students to participate equally in the classroom has statistically significant influence on student’s mathematics performance ($b = -2.94, p = 0.041$). This result shows teacher’s low ability to enable all students to participate equally in the classroom has a negative influence on the strength of the relationship between student’s perception about the level of difficulty of mathematics as a subject and student’s mathematics score. This means a unit increase on teacher’s ability to enable all students to participate equally in the classroom will increase students’ confidence in mathematics subject by 2.94.

6. Conclusions and recommendations

The results of this study showed that children from family support exhibit better academic performance and significantly determine student’s mathematics performance. This suggests that educational administrators should be aware of the importance of promoting family support role in children’s academic achievement. Students’ interest to learn mathematics is significantly positively determining their academic performance. Hence, the stakeholders, school administrators, and teachers should be work on how to increase their interest to learn mathematics. Parents should also support, encourage their children’s on their mathematics education and further research should do on how to advance students’ interest to learn mathematics. Whereas, the perception of mathematics as a difficult subject significantly but negatively associated to their academic performance, which is a problem that the government and teachers should work jointly with the community to change the perception of students that have a negative impact on their mathematics performance.

Giving feedback on homework to all students in the classroom was significantly and negatively related to students’ performance. Thus, the school should follow up and monitor the way teachers provide feedback and also provide workshops to teachers on how to give feedback for each student independently. Teacher’s ability to enable all students to participate equally in the classroom is an influential predictor and positively related to students’ mathematics performance. As a result, the school should exert more effort to develop teachers’ pedagogical skills on how to participate all students equally in the classroom. Cooperation between students and teachers in the classroom is positively determined students’ mathematics performance. So, the school should do more of
promoting academic cooperation between them by creating awareness of its impact on students’ mathematics performance

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References
[1] Atnafu M., Secondary School Mathematics Teachers’ Attitude in Teaching Mathematics. iSER-Mathematics Education, 9(1) (2014), 57-72.
[2] Baharin, S.H., Othman, R., & Azizan, N., Statistical analysis on the determinants of students’ academic achievement: a study in UITM johor, 2015. Retrieved from https://worldconferences.net/proceedings/gse2015/paper%20gse15/G%2020102%20STATISTICAL%20ANALYSIS%20ON%20THE%20DETERMINANTS%20OF%20STUDENT%20ACHIEVEMENT.pdf
[3] Fenstermacher, G. D., & Richardson, V., On making determinations of quality in teaching. Teachers College Record, 107(1) (2005), 186-213.
[4] Fuller, B., What school factors raise achievement in the third world? Review of Educational Research, 57 (3) (1987), 255-292.
[5] Hunde, A. B., Tegegne, K. M., Qualitative Exploration on the Application of Student-centered Learning in Mathematics and Natural Sciences: The case of Selected General Secondary Schools in Jimma, Ethiopia. Ethiop. J. Educ. & Sc. 6 (1) (2010).
[6] Klassen, R., A cross-cultural investigation of the efficacy beliefs of South Asian immigrant and Anglo Canadian nonimmigrant early adolescents. Journal of Educational Psychology, 96 (4) (2004), 731-742.
[7] Muhammad, H., Rafiq, W., Fatima, T., Sohail, M. M., Saleem, M., & Khan, M. A., Parental involvement and academic achievement; A study on secondary school students of Lahore, Pakistan. International Journal of Humanities and Social Science, 3(8) (2013), 209-223.
[8] Raudenbush, S. W., & Bryk, A. S., Hierarchical linear models: Applications and data analysis methods (Vol. 1). Sage, 2002.
[9] Ryan, R. M. and Deci, E. L., Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am. Psychol, 55(1) (2000), 68-78.
[10] Samdal, O., The school environment as a risk or resource for students' health-related behaviours and subjective well-being. University of Bergen-Research Center for Health Promotion, Faculty of Psychology, 1998.
[11] Skryabin, M., Zhang, J., Liu, L. & Zhang, D., How the ICT development level and usage influence student achievement in reading, mathematics, and science. Computers & Education, 85(C) (2015), 49-58. doi: 10.1016/j.compedu.2015.02.004.
[12] Veenstra, R., & Kuyper, H., Effective students and families: The importance of individual characteristics for achievement in high school. Educational Research and Evaluation, 10(1) (2004), 41-70.
[13] Walshaw, M., A powerful theory of active engagement. For the Learning of Mathematics, 24(3) (2004), 4-10.
[14] Winters, M. A., Haight, R. C., Swaim, T. T., & Pickering, K. A., The effect of same-gender teacher assignment on student achievement in the elementary and secondary grades: Evidence from panel data. Economics of Education Review, 34 (2013), 69-75. doi:10.1016/j.econedurev.2013.01.007.
[15] Woltman, H., Feldstain, A., MacKay, J. C., & Rocchi, M., An introduction to hierarchical linear modeling. Tutorials in Quantitative Methods for Psychology, 8(1) (2012), 52-69. doi: 10.20982/tqmp.08.1.p052.