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Impacts of Gender, Parents' Educational Background, Access to ICT, Use of ICT and School Quality on Students' Achievement:

A Study Based on the Indonesian Student Competency Assessment (AKSI) 2019 Data

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***Abstract*—AKSI as a national survey aims to monitor the quality of the education system across provinces. This includes determining factors that have impact on students' achievement in science, mathematics and reading skills. This study analyses four factors: gender, parents' educational background, students' access to ICT and use of ICT, and schools' quality. A hierarchical linear modelling was conducted to analyse 16,608 students as the smallest analysis unit which nested to 1,802 schools. The results show that access to ICT will not have any impact on students' achievement, unless the student makes use of the ICT facilities for learning. Parents' educational background and school quality have also impact. The interaction between parents' educational background and school quality shows that the two factors are not mutually exclusive, meaning that the effect of parental education on student achievement depends on the quality of the school and vice versa. This study concludes that although the parents' background and schools' quality are a key to student achievement, the indicator of schools' quality is not about simply having access to resources but about how resources are used to improve education outcomes.**

Keywords—AKSI, hierarchical linear modelling, ICT use

I. INTRODUCTION

The Indonesian Student Competency Assessment (AKSI) is a national survey aims to monitor the quality of the education system across provinces. Quality is determined by information from both the cognitive achievement of students and non-cognitive data of schools, teachers and students. Cognitive abilities are measured in mathematics, science and reading literacy while the non- cognitive data is measured by school climate, teaching and learning climate, social economic background, perception, behaviour and also beliefs. The results of AKSI are expected to provide input on policies to improve the quality of learning outcomes and the quality of education in general.

The 2019 AKSI survey included 86,307 grade IX students from 1,950 Junior High Schools (SMP) in all provinces in Indonesia. In addition to measuring students' cognitive abilities, AKSI also collected data through questionnaires, one of which was on technology, information and computer literacy (ICT literacy).

ICT literacy is the interest, attitude and ability of individuals to use digital and communication technology appropriately to access and manage information, acquire new knowledge, and communicate with others. The ability to use ICT and digital literacy by students will influence their performance (OECD 2018). Reading literacy on AKSI 2019 measured how well students understand text, use text, and connect the text content to real social life contexts. The additional ICT questionnaires capture their ability to use digital technology and communication tools in order to gather information, evaluate the quality and credibility of the information, comprehend the information then use it appropriately.

This article will discuss the effect of gender, parents' education level, availability of ICT devices at home and at school, intensity of ICT use, attitudes towards IT use and school quality on students' cognitive abilities.

II. METHODOLOGY

The data used in this study are the 2019 AKSI survey data and school accreditation data. The dependent variable is the cognitive abilities of students in mathematics (Y1), science (Y2) and reading literacy (Y3). Independent variables include student gender (X1), father's education level (X2), mother's education level (X3), availability of digital devices at home and at school (X4), intensity of use of digital devices (X5), intensity of use of digital devices for doing school work (X6), students' positive views of the benefits of ICT (X7) and school accreditation (Z). Accreditation variables are included in this analysis to determine the effect of school quality on student achievement.

After combining AKSI and school accreditation data, there was data from 16,608 students from 1,802 junior high schools (SMP) to be analysed.

The sampling method in the AKSI survey was carried out by using multi-stage stratified cluster probability sampling in which the first stage was randomly selected schools in each province by stratum, followed by selected clusters of sample students in each selected school. Therefore, the data has a hierarchical data structure where the lowest level data is students, who are nested in school. The analytical method is in accordance with the data structure in multilevel modelling or hierarchical linear models [1,2].

In this article, the method used is multilevel multiple linear regression with two levels where students are the first level and schools are the second level. Every j-school has n_j students. There are k independent variables X at the first level, and one independent variable Z at the second level, so the general form of the equation is:

$$Y_{ij} = \gamma_{00} + \sum_{l=1}^{L} \gamma_{l0} Z_{lj} + \sum_{k=1}^{K} \gamma_{0k} X_{kij} + \sum_{k=1}^{K} \sum_{l=1}^{L} \gamma_{lk} Z_{lj} X_{kij} + \left(\sum_{k=1}^{K} u_{kj} X_{kij} + u_{0j} + e_{ij} \right)$$

Where μ is a random component at the school level and e is a random component at the student level with u_{pj}~N(0,**D**) and e_{ij}~N(0,**Rj**).

Estimation of parameters used the maximum likelihood (ML) method, while testing the hypothesis on the regression coefficient used the Wald test.

III. Results and Discussion

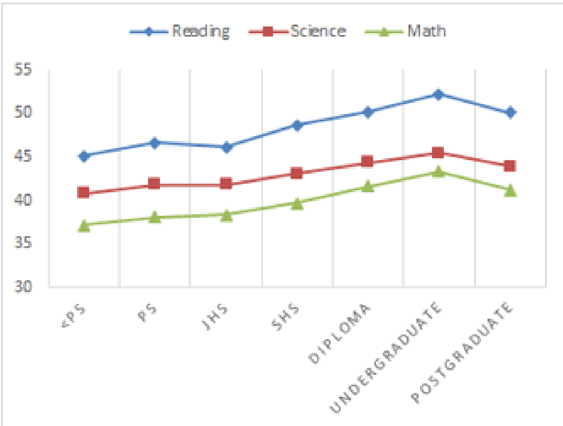
Based on the 2019 AKSI survey, results show that girls have higher average scores on reading literacy, science and mathematics. Based on the t-test, it was concluded that girls have a higher ability in reading literacy and science than boys (Table 1). Among the three abilities, the reading ability of girls is far better than boys. This phenomenon is similar to the results of research in several other countries, for example in Iran, girls have better scores in literacy, but not in mathematics [3].

TABLE I. Cognitive Skill Achievement Between Boys and Girls

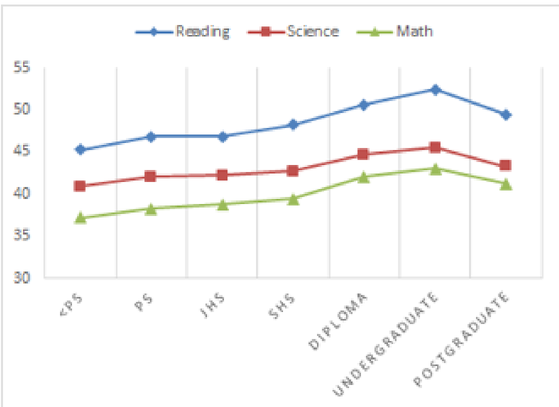
	Reading	Science	Math
Boys	46.89	42.47	39.33
Girls	48.96	42.95	39.46
Difference	2.17	0.48	0.13
T-Value	15.25	5.20	1.21
P-Value	0.00	0.00	0.22

The positive effect of parental education on children's achievement has been widely studied. Zhan [4], Yamamoto [5], Yamamoto and Holloway [6] and Khajehpour and Ghasvini [7] stated that parents with higher education are more confident in helping children, and have higher expectations for children's educational success and are more involved in their children's education.

Based on AKSI data in 2019, 45.2% of father's education and 44.3% of mother’s education are junior high school (JHS) level or below, 37.8% and 39.2% are at senior high school (SHS) level, as many as 17.1% and 15.6% are undergraduate or postgraduate. The data shows that students' skills in reading, science and mathematics tend to increase based on the level of education of their parents. The average score of the three subjects has the same trend. Students had the highest reading scores at each level of their father's and mother's education, while mathematics was the lowest. For students with parents with education levels up to junior high school, the average achievement score is relatively the same. Then the score increased rapidly to the level of undergraduate. However, what is interesting about this study is that the achievement score decreased again when the parents' education level was postgraduate (Figure 1).



(a) Father



(b) Mother

Fig. 1. Average score based on education level.

The instruments in the AKSI survey also asked students about the availability of digital equipment at home and at school. The digital equipment in question includes computers, smartphones, tablets, internet and software. The results of the analysis show that if the digital equipment is readily available it can improve students' cognitive scores (Figure 2). However, the availability of digital devices, internet in schools, the ease of access and the skills of teachers in using the internet for learning did not show an effect on increasing students' cognitive scores. (Figure 3). So the most likely factor affecting students' cognitive scores is the availability of digital equipment at home compared to school.

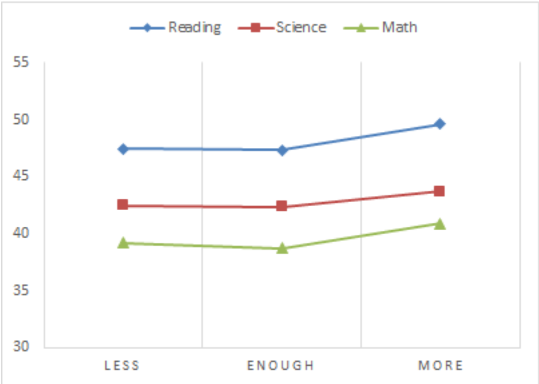


Fig. 2. Average score based on digital device availability at home and school.

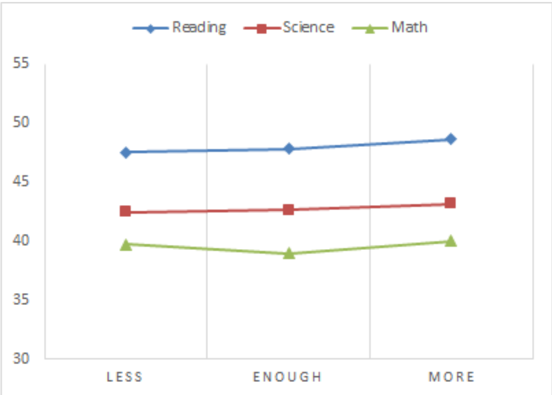


Fig. 3. Average score based on the availabilty of digital devices at school and the skill of teachers in using ICT for learning.

What is interesting about the results of this survey is how students take advantage of existing digital equipment and facilities and how students perceive ICT technology. The more intensive students use digital equipment to do school work, for example making presentations, searching for digital information and accessing digital content, the higher the student's cognitive score (Figure 4).

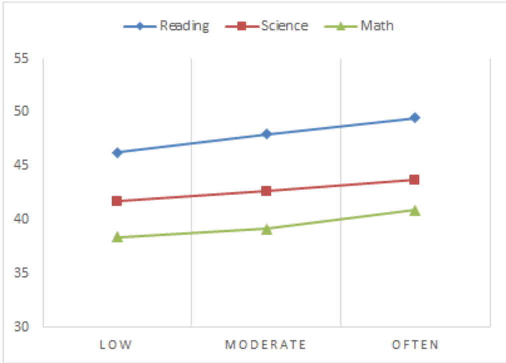


Fig. 4. The average AKSI score based on the intensity of the use of digital devices for school work.

Students' belief in the importance of information technology for science will stimulate students to seek more information and learn. This is shown in Figure 5 where the more students agree with the positive view of the importance of ICT, the higher the cognitive score.

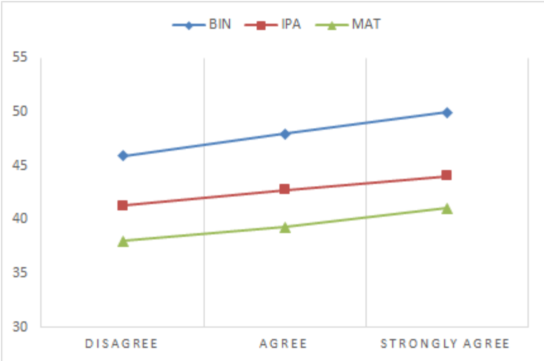


Fig. 5. The Average AKSI Score based on the positive view on ICT.

Student academic achievement is not only influenced by individual students but also by school quality. AKSI and accreditation data show the average score of reading, science and mathematics increasing linearly with school accreditation rankings (Figure 6). The relationship between AKSI scores and accreditation is in accordance with the relationship between accreditation and the results of the computer-based national exam [8].

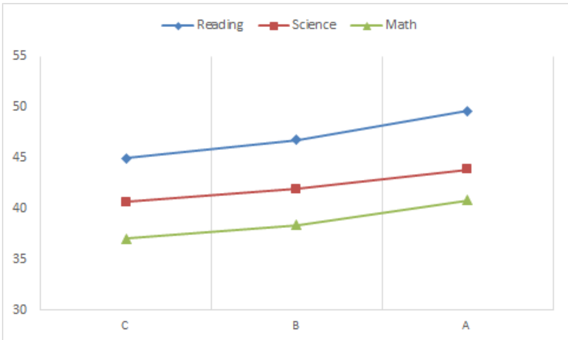


Fig. 6. The average AKSI Score based on the school accreditation ranking.

The following is a discussion of the results of the confirmatory analysis to test the effect of independent variables on the average score of science, mathematics and reading literacy.

A. Science

Based on the statistical test between the null model (Model 0) and the intercept only model (Model 1), Chisq = 1682.68 (p-value = 0.000) which indicates that there is an effect of schools on the science score. Intra class correlation (ICC) was 21.1%, meaning that the school factor contributed 21.1% to explain the diversity of students' science scores.

The best model for estimating the regression coefficient between independent variables on the science score and the results of hypothesis testing can be seen in Table 2. From this model it can be concluded that gender (X1), father's education level (X2), intensity of using digital devices for schoolwork (X6) and students' positive views of ICT (X7) has an effect on the science score. Among these variables, X7 has the greatest influence, followed by X6. This means that students who have a positive perception of the importance of ICT and students who use digital devices a lot for school purposes have a major effect on increasing students' science scores.

TABLE II. THE COEFFICIENTS AND THE RESULTS OF TESTING THE BEST MODEL FOR THE IPA SCORE

Variable	Coefficient	Std.error	t-value	p-value
Intercept	21.5038	1.9667	10.9340	0.0000
X1	-0.4144	0.0923	-4.4899	0.0000
X2	-0.3543	0.1671	-2.1196	0.0341
X6	3.8301	1.0933	3.5032	0.0005
X7	16.3016	1.3893	11.7335	0.0000
Z	0.1075	0.0206	5.2304	0.0000
X2:Z	0.0055	0.0019	2.9336	0.0034

The model from Table 2 is as follows:

Model level-1:

$$\hat{Y}_{ij} = \beta_{oj} + \beta_{1j}X_{1ij} + \beta_{2j}X_{2ij} + 3.830054\,X_{6ij} + \beta_{7j}X_{7ij}$$

Model level-2:

$$\beta_{oj} = 21.503768 + 0.107516Z + u_{0j}$$

$$\beta_{1j} = -\,0.414425 + u_{1j}$$

$$\beta_{2j} = -\,0.354259 + 0.005540Z \;\; + u_{2j}$$

$$\beta_{7j} = 16.301617 + \; u_{7j}$$

The variables X1, X2 and X7 have random coefficients, meaning that the effect of these three variables on the science ability in a school varies greatly between students. Apart from being influenced by individual students, school quality (Z) also affects students' science scores. The better the accreditation ranking, the better the average science score. The interaction between X2 and Z indicates that the effect of the father's education level on the science score differs between the school accreditation rankings.

B. Mathematics

Based on the test between the null model (Model 0) and the intercept only model (Model 1), Chisq = 2240.80 (p-value = 0.000) which indicates that there is an effect of schools on the average mathematics score. Intra class correlation (ICC) was obtained at 24.8%, meaning that the school factor contributed 24.8% explaining the diversity of mathematics scores.

The best model obtained and the results of testing the hypothesis as in Table 3 shows that the variables X2, X3, X5, X6, X7 and Z have an effect on the math score. The test results show that the effect of all these variables is random, which means that the influence of these variables varies between students. As with science scores, student perceptions of the benefits of IT (X7) have the greatest influence on students' Mathematics scores, followed by the use of digital devices for school purposes (X6).

TABLE III. COEFFICIENTS AND RESULTS OF TESTING THE BEST MODEL FOR MATHEMATICS SCORES

Variable	Coefficient	Std. error	t-value	P-value
Intercept	24.1900	2.3250	10.4040	0.0000
X2	0.1330	0.0180	7.1710	0.0000
X3	-0.9610	0.1960	-4.8850	0.0000
X5	-4.8940	1.7870	-2.7380	0.0000
X6	6.4340	1.3200	4.8750	0.0000
X	14.1200	1.4460	9.7660	0.0000
Z	0.0690	0.0230	2.8670	0.0000
X3:Z1	0.0110	0.0220	5.2880	0.0000

The model from Table 3 is as follows:

Model level-1:

$$\hat{Y}_{ij} = \beta_{oj} + \beta_{2j}X_{2ij} + \beta_{3j}X_{3ij} + \beta_{5j}X_{5ij} + \beta_{6j}X_{6ij} + \beta_{7j}X_{7ij} + e_{ij}$$

Model level-2:

$$\beta_{oj} = 24.190 + 0.069\,Z_1 + u_{oj}$$

$$\beta_{2j} = 0.133 + u_{2j}$$

$$\beta_{3j} = -0.961 + 0.011\,Z_1 + u_{3j}$$

$$\beta_{5j} = -4.894 + u_{5j}$$

$$\beta_{6j} = 6.434 + u_{6j}$$

$$\beta_{7j} = 14.120 + u_{7j}$$

The interaction between mother’s education level (X3) and school accreditation (Z) indicates that the effect of mother’s education level on mathematics scores differs between school accreditation rankings. The effect of mother's education level in schools with C accreditation is not significant, while in schools with B or A accreditation it has a very significant effect, especially high school education level or above.

C. Reading

Based on the test between the null model (Model 0) and the intercept only model (Model 1), Chisq = 1646.1 (p-value = 0.000) which indicates that there is an effect of schools on the average reading literacy score with the Intra class correlation (ICC) of 16, 7%.

The best model and the results of hypothesis testing show that X4 and X5 have no effect on reading literacy scores. The effect of variables X1, X2 and X3 are random, while X6 and X7 are fixed (Table 4).

TABLE IV. COEFFICIENTS AND RESULTS OF TESTING THE BEST MODEL FOR READING SCORES

Variable	Coefficient	Std. error	t-value	P-value
Intercept	26.7652	2.7526	9.7238	0.0000
X1	-1.9215	0.1254	-15.3272	0.0000
X2	0.1876	0.0232	8.0948	0.0000
X3	-1.2981	0.2426	-5.3508	0.0000
X6	6.3628	1.5718	4.0482	0.0001
X7	18.2459	1.7112	10.6626	0.0000
Z	0.0777	0.0294	2.6436	0.0083
X3:Z	0.0157	0.0027	5.7151	0.0000

The model from Table 4 is a follows:

Model level-1:

$$\hat{Y}_{ij} = \beta_{oj} + \beta_{1j} X_{1ij} + \beta_{2j} X_{2ij} + \beta_{3j} X_{3ij} + 6.280\, X_{6ij} + 18.15\, X_{7ij} + e_{ij}$$

Model level-2

$$\beta_{oj} = 24.504 + 0.076\, Z + u_{oj}$$

$$\beta_{1j} = 1.921 + u_{1j}$$

$$\beta_{2j} = 0.188 + u_{2j}$$

$$\beta_{3j} = -1.302 + 0.015\, Z + u_{3j}$$

Similar to the phenomenon in the model for science and mathematics scores, students' positive perceptions of ICT (X7) has the greatest influence on reading literacy scores, followed by the use of digital devices for school purposes (X6). The more positive the level of students 'perceptions of the benefits of ICT (X7) and the more intensively students use digital devices to complete school assignments (X6), the better the scores for students' reading literacy. Further, similar to the model for mathematics, the reading literacy model also has an interaction between the mother's education level (X3) and school accreditation (Z).

IV. CONCLUSION

Based on the 2019 AKSI data analysis, it can be concluded that the average student's ability in reading literacy, science and mathematics is very low and needs special intervention. However, reading literacy skills show the highest score, followed by science and mathematics. Factors that affect the science score include student gender (X1), father's education level (X2), use of digital devices for school purposes (X6) and student perceptions of ICT (X7). For mathematics scores, except for the gender factor (X1), all other variables have a significant effect. For reading literacy, only the availability of digital devices at home and at school (X4), and the intensity of use of digital devices (X5) were not significant.

Some variables have random coefficients, meaning that the effect varies between students in a school. In the science score model, the random variables are X1, X2 and X7. In the mathematical scoring model, all influencing variables are random, while the random reading scores are X1, X2 and X3. Based on the comparison of Deviance Model-0 and Model-1, it is concluded that school quality has an effect on the achievement of scores of the three subjects.

The results of the analysis show that there is an interaction between the father's education level (X2) and accreditation on the IPA score. For mathematics and reading scores, the variable that interacts with accreditation is the level of mother's education (X3). This amplifies the importance of schools' quality on supporting students' cognitive achievement, regardless their social economic background.

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