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SCHOOL TYPE AS A PREDICTOR OF STUDENTS' STATISTICAL LITERACY: CONTROLLING FOR GENDER AND PARENTAL EDUCATION

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Abstract

In today's data-driven era, the rapid growth of big data has made encounters with data unavoidable for everyone, including students. Therefore, preparing students with adequate statistical literacy has become increasingly important. This study employed a quantitative non-experimental design using an ex post facto approach. It examined and compared students' statistical literacy across three types of schools in Aceh, Indonesia. More specifically, the study investigated whether school type predicted students' statistical literacy after controlling for gender and parental education. Data were collected through a statistical literacy test and a brief demographic questionnaire covering gender and parental educational background. The data were analyzed using hierarchical multiple regression and Tukey HSD post hoc analysis. The findings showed that gender and parental education did not significantly influence students' statistical literacy, whereas school type did. These results suggest that different school environments may offer distinct learning experiences and opportunities for statistical reasoning and data literacy.
Keywords: *gender difference; parental education; statistical literacy; school type*

Abstrak

Di era berbasis data saat ini, pertumbuhan big data yang semakin pesat membuat setiap individu, termasuk siswa, tidak dapat terlepas dari paparan data dalam kehidupan sehari-hari. Oleh karena itu, mempersiapkan siswa dengan kemampuan literasi statistik yang memadai menjadi semakin penting. Penelitian ini menerapkan desain penelitian kuantitatif non-eksperimental dengan pendekatan ex post facto. Penelitian ini bertujuan untuk mengkaji dan membandingkan literasi statistik siswa pada tiga jenis sekolah di Aceh. Secara khusus, penelitian ini meneliti apakah jenis sekolah memprediksi literasi statistik siswa setelah mengontrol gender dan pendidikan orang tua. Data dikumpulkan melalui tes literasi statistik dan kuesioner singkat terkait gender serta latar belakang pendidikan orang tua. Data dianalisis menggunakan hierarchical multiple regression dan uji lanjut Tukey HSD. Hasil penelitian menunjukkan bahwa gender dan pendidikan orang tua tidak berpengaruh signifikan terhadap literasi statistik siswa, sedangkan jenis sekolah menunjukkan pengaruh yang signifikan. Temuan ini mengindikasikan bahwa lingkungan sekolah yang berbeda dapat memberikan pengalaman belajar dan kesempatan yang berbeda pula dalam mengembangkan kemampuan penalaran statistik dan literasi data siswa.
Kata kunci: perbedaan gender; pendidikan orang tua; literasi statistic; jenis sekolah

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INTRODUCTION

The use of statistics and data-driven information in this information age is becoming increasingly widespread, requiring students to possess adequate statistical literacy. Data-driven algorithms offer both the promise and the potential dangers for making decisions intended to serve the public interest (Lepri et al., 2017). The abundance of quantitative data available to the public, including junior high school students, exposes them to a wide variety of confusing data and data-driven reports. Low statistical literacy can lead students to draw incorrect conclusions or make inaccurate judgments based on the available information. Statistical data is inseparable from daily life. Examples of statistical data students encounter in daily life include weather forecasts, news reports, social media insights (likes and followers), currency exchange trends, product advertisements that report limited product trials, and predictions of World Cup winners. One key aspect of statistical literacy is knowing which data and information are trustworthy and reliable (Australian Bureau of Statistics, 2009). Therefore, students, as citizens who will encounter statistical data and information in their daily lives, need adequate statistical literacy. Educational programs at all levels aim to prepare learners to function effectively in a data-driven society. This involves integrating statistical literacy into curricula to ensure students develop the necessary skills to interpret and evaluate statistical information (Antoniassi & da Silva Dias, 2022).

Despite the importance of statistical literacy for students as part of preparing them to be citizens with sound statistical literacy, many students show poor ability to interpret data, draw conclusions, and generally evaluate quantitative information. Students' poor ability to interpret data, draw conclusions, and evaluate quantitative information is a multifaceted issue that spans educational levels and contexts. Some studies have shown that students often struggle with statistical literacy (Hassan et al., 2020; Pham et al., 2024), a crucial skill for understanding and applying quantitative information in real-world contexts. These challenges are evident across different age groups and educational settings, including in Indonesia. Some previous studies have highlighted the statistical literacy problems among Indonesian students (Habibie et al., 2023; Setio, 2023). A study by Herlambang et al. (2025) among junior high school students found that only 17.5% demonstrated a high level of statistical literacy, with the majority falling into the medium or low categories.

The problem with statistical literacy was not only encountered by primary and secondary students but also by mathematics student teachers (Retnawati et al., 2024). Another study argued that the level of statistical literacy among prospective teachers varied (Herlina et al., 2024). These previous studies highlight the urgency of exploring factors contributing to students' statistical literacy.

Students' statistical literacy is influenced by various factors, including gender, family educational background (parental education), and school types. Schools play a paramount role in students' statistical literacy. Those who place greater emphasis on statistics in mathematics lessons are more likely to help students achieve stronger statistical literacy skills (Yensy, 2025). In addition, curriculum reforms that incorporate statistical literacy across subjects can strengthen students' critical thinking and data interpretation (Watson, 2015). Socioeconomic status, including parents' education, can affect students' statistical literacy by influencing their access to educational resources and learning opportunities. Students from higher socioeconomic backgrounds generally have greater access to quality schools, learning materials, and academic support, which can contribute to stronger statistical literacy skills (Sproesser et al., 2014). Researchers have also examined demographic factors such as age, gender, and grade level in relation to statistical literacy. However, existing studies have produced mixed results, and there is still no clear conclusion about how strongly these factors directly influence students' statistical literacy (Aziz & Rosli, 2021; Retnawati et al., 2024).

The mixed results of studies on factors influencing statistical literacy warrant further study. Although some studies have examined the factors contributing to students' statistical literacy, fewer have comparatively investigated whether school type exerts a stronger influence than demographic characteristics, particularly across public, public Islamic, and private Islamic schools. This study is particularly important in the Indonesian context as Indonesia has diverse school systems, including public schools, public Islamic schools, private schools, and private Islamic schools. These schools may differ in governance, curricular emphasis, resource allocation, and instructional culture, thereby shaping distinct learning opportunities. Therefore, this study aims to examine differences in students' statistical literacy across school types while controlling for gender and parental education. This study addresses the following research questions: 1) Is there a significant simultaneous effect of school type, gender, and parental education on students' statistical literacy?; 2) Does school type significantly predict students' statistical literacy after controlling for gender and parental education?, 3) Do gender and parental education significantly contribute to students' statistical literacy?; 3) How does students' statistical literacy differ among Islamic public, public, and private Islamic schools?

METHOD

This study employed a quantitative non-experimental design using an ex post facto approach. Ex post facto research refers to a non-experimental design in which researchers examine the effects of pre-existing independent variables that cannot be manipulated, as these variables are typically inherent characteristics or life circumstances (Black, 1999). It aims to examine differences

in students' statistical literacy across school types and to determine whether school type predicted statistical literacy after controlling for gender and parental education.

The participants were 238 Year 8 students from three schools in Banda Aceh, Indonesia: one public school, one public Islamic school, and one private Islamic boarding school. The schools were selected purposively to include three institutional settings. The selection criteria included the same educational level, implementation of the national curriculum, and location within Banda Aceh, which helped minimize variation due to geographical factors. In addition, only schools that granted permission and agreed to participate were included in the study. Accordingly, the selected schools provided comparable educational contexts for examining possible differences in students' statistical literacy across school types. The instrument used in this study was a statistical literacy test to examine students' statistical literacy. The test consisted of seven long-answer items, adapted from Yolcu (2012) and Schield (2006). Prior to data collection, the statistical literacy test underwent face and expert validity procedures to ensure the items were valid. Both validators are experts in mathematics education. The test items were deemed valid before the data collection proceeded. However, no separate reliability analysis was conducted in the present study. The statistical literacy framework used in this study was understanding basic statistical terminology, Understanding terminology when it appears in a social context, and the ability to question claims that are made in context without proper statistical justification (Watson, 2015).

SPSS 29 was used to analyze the data. Descriptive statistics were conducted to summarize the participants' demographics. To examine whether students' statistical literacy differed across the three school types, a one-way analysis of variance (ANOVA) was performed. If the overall ANOVA result is statistically significant, Tukey's Honestly Significant Difference (HSD) post hoc test can identify which pairs of school types differ significantly, comparing the mean statistical literacy scores of students from the three schools.

Hierarchical multiple regression was conducted to evaluate the extent to which school type predicted students' statistical literacy, while accounting for demographic characteristics. This analysis allows predictors to be entered in blocks, enabling the researchers to assess the additional explanatory power of school type beyond that of gender and parental education. In the first block, gender, father's educational level, and mother's educational level were entered as control variables. In the second block, school type was added using two dummy variables, with the public school serving as the reference category. The first dummy variable represented the public Islamic school, and the second represented the private Islamic school.

The F-test was used to assess the significance of each model, while the proportion of explained variance was assessed using the coefficient of determination (R^2). The change in R^2 (ΔR^2)

between Blocks 1 and 2 determined the unique contribution of school type to students' statistical literacy.

RESULTS AND DISCUSSION

This study involved three schools in Banda Aceh, Indonesia. The demographic data for school type and gender are presented in Tables 1 and 2.

Table 1. Descriptive statistics of Gender * Type of Schools

Type of Schools	Gender		Total
	Female	Male	
Public School	44	44	88
Public Islamic School	68	37	105
Private Islamic School	23	22	45
	135	103	238

Table 2. Descriptive statistics of Parental education* Type of Schools

	Father Education						
	Junior High School	Senior High School	Diploma	Bachelor Degree	Master Degree	Doctoral	Total
	1	37	1	25	9	3	76
Public School	1	8	2	37	16	6	70
Public Islamic School	0	8	0	16	7	3	34
Private Islamic School	2	53	3	78	32	12	180
	Mother Education						
Public School	35	0	3	35	4	1	78
Public Islamic School	9	0	11	38	13	3	74
Private Islamic School	6	0	1	23	6	0	36
	50	0	15	96	23	4	188

This study involved 238 students from three secondary schools in Banda Aceh: one public school, one public Islamic school, and one private Islamic school. Table 1 presents the distribution of participants by school type and gender. The largest proportion of students came from the public Islamic school (105 students, 44.1%), followed by the public school (88 students, 37.0%) and the private Islamic school (45 students, 18.9%). Overall, the sample included 135 female students (56.7%) and 103 male students (43.3%). The gender composition was balanced in the public school, with 44 female and 44 male students. The private Islamic school also showed a relatively even distribution (23 females and 22 males). In contrast, the public Islamic school had a notably higher proportion of female students (68, 64.8%) than male students (37, 35.2%).

Table 2 summarizes parental educational attainment across the three school types. In general, most students came from families in which at least one parent had completed higher education. Bachelor's degree holders constituted the largest category for both fathers and mothers.

Among fathers, 78 individuals (43.3%) held a bachelor's degree, 32 (17.8%) a master's degree, and 12 (6.7%) a doctoral degree. For mothers, 96 individuals (51.1%) held a bachelor's degree, 23 (12.2%) had a master's degree, and 4 (2.1%) held a doctoral degree. Only a small proportion of parents had educational attainment at the junior or senior high school level. Overall, these data indicate that the sample was drawn from families with relatively high levels of education, which is an important consideration when interpreting the limited effect of parental education on students' statistical literacy.

To address RQ1 and RQ2, hierarchical multiple regression analysis was conducted. Although the study involved 238 students, the hierarchical multiple regression analysis was conducted using 194 cases with complete information on the variables included in the model. Parental education was operationalized as the highest educational attainment of either parent. Cases with missing information for both parents were excluded from the regression analysis. In contrast, the one-way ANOVA and Tukey HSD analyses used the full sample of 238 students because these analyses required only students' statistical literacy scores and school type. The results are presented in Tables 3 and 4.

Table 3. Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R-Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.122[a]	0.015	0.04	3.622	0.015	1.436	2	191	0.240
2	.501[b]	0.251	0.235	3.175	0.236	29.758	2	189	<0.001

a. Predictors: (Constant), Parental Education, Gender

b. Predictors: (Constant), Parental Education, Gender, V3=Private Islamic School, V3=Public Islamic School

Table 4. ANOVA results

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	37.674	2	18.837	1.436	.240[b]
	Residual	2505.831	191	13.129		
	Total	2505.831	193			
2	Regression	637.792	4	159.448	15.813	<.001[c]
	Residual	1905.714	189	10.083		
	Total	2330.805	193			

a. Dependent Variable: Statistical Literacy Score

b. Predictors: (Constant), Parental Education, Gender

c. Predictors: (Constant), Parental Education, Gender, Father Education, V3=Private Islamic School, V3=Public Islamic School

In the first model (demographic factors model), gender and parental education were entered as control variables. The model was not statistically significant, $F(2,191)=1.436$, $p=.240$, explaining only 1.5% of the variance in students' statistical literacy ($R^2=.015$). This finding suggests that gender and parental educational background alone were not sufficient to explain differences in

students' statistical literacy scores. Next, the school type was added to the second model as dummy variables, with public schools as the reference category. The second model (school context model) was statistically significant, $F(4,189)=15.813$, $p<.001$, accounting for 25.1% of the variance ($R^2=.251$). Moreover, the inclusion of school type significantly improved the model, resulting in an increase of 23.6% in explained variance ($\Delta R^2 = .236$, $p < .001$). These findings indicate that school type contributed substantially to explaining students' statistical literacy beyond the effects of gender and parental education.

To address RQ3, the regression coefficients were examined (Table 4). Neither gender (B = -0.078, p = .871) nor parental education (B = -0.175, p = .418) significantly predicted students' statistical literacy. Regarding school type, no significant difference was found between students from the public school and those from the public Islamic school (B = -0.541, p = .327). However, students from the private Islamic school obtained significantly lower scores in statistical literacy than students from the public school (B = -4.791, β =- .514, p < .001). Overall, these findings suggest that school context plays a more important role in explaining differences in statistical literacy than demographic background factors.

Table 5. Coefficients

Model		Unstandardized Coefficients	Standardized Coefficients	T	Sig.	Collinearity Statistics		
B		Std. Error	Beta	Tolerance	VIF			
1	(Constant)	13.279	0.755		17.599	<.001		
Gender		-0.011	0.528	-0.002	-0.021	0.983	0.996	1.004
Parental Education		-0.39	0.231	-0.122	-1.689	0.093	0.996	1.004
2	(Constant)	13.774	0.672		20.486	<.001		
Gender		-0.078	0.478	-0.011	-0.163	0.871	0.931	1.075
Parental Education		-0.175	0.216	-0.055	-0.811	0.418	0.875	1.143
V3= Public Islamic School		-0.541	0.551	-0.073	-0.982	0.327	0.713	1.402
V3= Private Islamic School		-4.791	0.656	-0.514	-7.305	<.001	0.8	1.251

a. Dependent Variable: Statistical Literacy Score

Table 6. Tukey HSD

(I) School	(J) School	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Public School	Public Islamic School	0.371	0.446	0.683	-0.68	1.42
	Private Islamic School	4.936*	0.565	<0.000	3.60	6.27
Public Islamic School	Public School	-0.371	0.446	0.683	-1.42	0.68
	Private Islamic School	4.565*	0.549	<0.000	3.27	5.86
Private Islamic School	Public School	-4.936*	0.565	<0.000	-6.27	-3.60
	Public Islamic School	-4.565*	0.549	<0.000	-5.86	-3.27

*. The mean difference is significant at the 0.05 level.

To address RQ4, a one-way analysis of variance (ANOVA) followed by Tukey HSD post hoc analysis was conducted to compare students' statistical literacy across the three school types. The results are presented in Table 6. Prior to the analysis, Levene's test indicated that the assumption of homogeneity of variances was met ($F(2,235)=0.595$, $p=.553$). The ANOVA results revealed a significant difference in students' statistical literacy among the three groups, $F(2,235)=43.372$, $p<.001$, with a large effect size ($\eta^2=.270$). Students from the public school ($M=13.11$, $SD=2.88$) and the public Islamic school ($M=12.74$, $SD=3.23$) achieved relatively similar scores, whereas students from the private Islamic school ($M=8.18$, $SD=3.12$) obtained considerably lower scores. The Tukey HSD post hoc analysis showed no significant difference between the public school and the public Islamic school ($p=.683$). However, both groups scored significantly higher than the private Islamic school, with mean differences of 4.936 and 4.565 points, respectively (both $p<.001$). These findings suggest that while students from public and public Islamic schools demonstrated comparable levels of statistical literacy, students from the private Islamic school tended to perform substantially lower.

The findings of this study showed that gender and parental education did not significantly predict students' statistical literacy. This suggests that students may have had relatively similar learning opportunities in statistics regardless of their demographic background. This result regarding gender is in line with a previous study conducted on Indonesian students (Salam et al., 2023), which reported no gender difference in statistical literacy among junior high school students, but contradicts another study by Risqi & Ekawati (2020). This finding contrasts with Martin et al. (2017), who found a persistent gender gap in statistical reasoning, with females underperforming males. However, this study aligns with Prabhakaran (2025), who noted that the global trend in statistical literacy shows a move toward gender equity. Similarly, the non-significant role of parental education in this study may suggest that formal instructional experiences more strongly influence statistical literacy than by parental educational level. Statistical literacy involves interpreting data, evaluating statistical information, and reasoning within real-life contexts. Students' opportunities to engage with such activities in school may be more influential than demographic factors. The classroom learning model has been shown to significantly improve students' statistical literacy (Pham et al., 2024), and engaging students with real-world data and contexts is crucial for enhancing their statistical literacy (MacGillivray, 2021).

In contrast, school type emerged as the strongest predictor of students' statistical literacy in this present study. The results of the hierarchical multiple regression analysis showed that school type explained a substantial proportion of the variance, even after controlling for gender and parental education. This finding shows how crucial school context is in shaping students' development of statistical literacy. Different school environments may provide different levels of

exposure to data interpretation tasks and classroom discussion related to statistical literacy. Hands-on learning in schools, such as analyzing (mis)representations in the media, can significantly enhance students' statistical literacy skills and may be more influential in fostering statistical literacy than demographic factors (Delport, 2023). Therefore, differences in instructional practices, curriculum implementation, and assessment culture across schools may contribute to variations in students' achievement in statistical literacy. This interpretation is consistent with the opportunity-to-learn (OTL) theory introduced by Carroll (1963). This theory emphasizes that differences in students' learning outcomes are partly shaped by variations in instructional experiences and access to learning opportunities (Elliot, 2015).

A particularly interesting finding was that students from the private Islamic school scored significantly lower than students from both the public school and the public Islamic school. This finding should be interpreted carefully and does not necessarily indicate lower overall educational quality. The private Islamic school involved in this study operates as a boarding school, which may create a different educational structure and learning emphasis compared to the other two schools. Instructional priorities, classroom time allocation, or academic focus in the boarding school environment may differ from those in public schools.

One possible explanation relates to the dual curriculum structure commonly implemented in Islamic boarding schools in Aceh. In addition to following the national curriculum, students are also required to engage in religious studies, including Quranic studies, Arabic, and Islamic subjects. As a result, students are expected to meet learning demands from both academic and religious domains. From the perspective of OTL theory, differences in achievement may arise from differences in instructional time, curriculum coverage, and students' exposure to learning activities (Perry et al., 2024). Consequently, the broader educational responsibilities within the boarding school system may lead to different instructional emphases and fewer opportunities for students to engage in statistical reasoning and data interpretation. Since statistical literacy develops through meaningful interaction with data and contextual problems, variations in these learning opportunities may partially explain the lower statistical literacy scores observed among students from the private Islamic boarding school.

Nevertheless, these findings should not be interpreted as indicating lower educational quality, but rather as suggesting that differences in educational structure and curricular priorities may shape students' opportunities to develop statistical literacy. Another notable finding was the absence of a significant difference between students from the public school and the public Islamic school. Although these schools differ in institutional identity and educational orientation, students from both schools demonstrated relatively similar levels of statistical literacy. One possible explanation is that both schools operate within the same public educational system and follow

similar curriculum standards, teacher qualification requirements, and national assessment expectations. Consequently, students may receive comparable exposure to mathematics and statistics instruction despite differences in school identity.

The findings of this study have several practical implications. Since school context appears to play a more influential role than demographic background variables, efforts to improve students' statistical literacy should focus more strongly on instructional and institutional factors. Schools may benefit from providing more opportunities for students to engage in data interpretation, statistical reasoning, and real-world problem-solving activities. Additional instructional support may be particularly important in school contexts where students demonstrate lower levels of statistical literacy.

CONCLUSION

In conclusion, this study found that students' statistical literacy was influenced more by school-related factors than by demographic background. Gender and parental education were not significant predictors of statistical literacy, whereas school type showed a clear contribution. Students from the private Islamic boarding school generally achieved lower statistical literacy scores compared to students from the public school and the public Islamic school. Meanwhile, the results between the public school and the public Islamic school were quite similar. This may indicate that students in both schools experienced relatively comparable learning opportunities, particularly in mathematics and statistics instruction. The findings of this study suggest that strengthening statistical literacy should be an important focus at the school level, especially through learning activities that encourage students to read, interpret, and discuss data meaningfully. In particular, teachers in private Islamic boarding schools are recommended to increase students' exposure to statistical reasoning and data interpretation tasks.

Several limitations should also be acknowledged. This study only examined demographic variables and school type, so it could not fully explain why differences in statistical literacy occurred across schools. In particular, the study did not investigate classroom teaching practices, students' learning experiences, or how statistics were actually taught in each school. Since the private Islamic school in this study is also a boarding school, differences in learning schedules, academic priorities, or classroom exposure may have influenced students' opportunities to engage with statistical learning activities. Another limitation concerns the measurement instrument. Although the statistical literacy test was evaluated for face and expert validity, its reliability was not examined. Consequently, caution should be exercised when interpreting the results, and future studies are encouraged to establish the instrument's reliability through appropriate analyses, such as internal consistency measures or test–retest procedures. Future studies could also explore these issues

further by conducting classroom observations, interviewing teachers and students, or using mixed-methods approaches to better understand how school environments influence students' development of statistical literacy.

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