



Will private schools in distance education achieve higher academic performance?

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Abstract. The implementation of online education during the epidemic provides researchers with a window to study the quality of distance education in secondary education. With the help of PISA2022 sample data from public and private schools implementing distance education worldwide, a multi-layer linear model (HLM) and propensity score matching estimation (PSM) are used to explore whether private schools have a relative advantage in student performance based on their own educational characteristics, and whether personal qualities can better improve academic performance in distance education, It may also be due to school investment factors. Research has found that after controlling for student background, personal qualities, and learning time, although the academic performance advantages of private schools have decreased significantly, they still have significant advantages. This conclusion confirms that private schools in distance education do have their own characteristics in running schools. However, empirical conclusions do not reject the fact that the advantages of private schools partly come from screening out good student sources, The achievement of high grades in distance education depends more on the personal qualities of students, which also points out the direction for implementing digital education in private schools.

Keywords: PISA2022; Distance Education; Academic Performance; Private.

1 Introduction

Research on the quality of distance education teaching mostly focuses on higher education. However, given that most countries around the world adopt distance education as a means of primary and secondary education during the pandemic, this provides researchers with a window to observe the quality of distance education teaching in the secondary education stage. According to multiple empirical surveys, the teaching performance of private schools worldwide is significantly higher than that of public schools, Can this academic advantage continue in distance education? The VOLUM II report from PISA2022 reveals that principals in private schools are more likely than those in public schools to report that their schools are prepared for distance learning. [1]Therefore, based on national data from PISA2022 adopting distance education, this study aims to answer two core questions: (1) Can choosing private schools in distance

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Y. Li et al. (eds.), *Proceedings of the 2024 3rd International Conference on Science Education and Art Appreciation (SEAA 2024)*, Advances in Social Science, Education and Humanities Research 866,

https://doi.org/10.2991/978-2-38476-291-0_67

education lead to higher academic performance? (2) If so, is this because private schools have taken better distance education support measures? Or is it just because private schools screen out students with strong self-learning abilities when they enroll?

2 Literature Review and Research Hypotheses

There are abundant comparative research results on the quality of teaching performance in private and public schools both domestically and internationally. Most of these empirical studies believe that private schools have higher teaching performance than public schools. For example, in a study of developing countries, Anand (2009) found that students from low-income families in Chile scored significantly higher in standardized tests than those from public schools [2] In research on developed countries, the National Assessment of Educational Progress (NAEP) report shows that students in private schools perform better academically than those in public schools. [3] However, some scholars believe that such differences in academic performance are caused by student backgrounds. For example, Elder (2014) found no significant difference between private and public academic performance after screening similar student backgrounds (personal cognition and family background).[4]

However, research on the quality of distance education teaching mostly focuses on higher education. Some studies the educational philosophy of distance education in order to provide theoretical support for it, such as the lifelong education perspective,[5] Social interaction theory[6]. Some pay attention to the quality analysis and improvement strategies of distance education in higher education, such as selecting social interaction as a measurement indicator,[7] Or using the analysis of cognitive patterns as a starting point. [8] However, there is relatively little research on distance education within the scope of secondary education.

Moreover, scholars have different opinions on the factors affecting the difference in academic quality between private and public schools. For example, some scholars believe that the size of schools and classes. [9] Resource conditions (Soft[10], hard[11]), Highly educated teachers. [12] Both will affect the academic performance differences of public and private students. According to the research of Yao Hao and Zhang Ying, they divided these factors into two types: one belongs to the "source selection" factor, which is the individual and family factors of students, and the other belongs to the "school optimization" factor, which is the school resource factor.[13] Therefore, this article draws on this classification, combined with the factors affecting the quality of distance education measured by PISA2022, and compiles the following variables (Table 1), proposing hypotheses:

H1: After controlling the background of students, the average grades of students in private schools implementing distance education are still significantly higher than those in public schools.

H2: In distance education, students' personal digital literacy and learning ability have a greater impact on academic performance than school factors.

Table 1. A brief statistical description of the main variables

| Variable Type | Name of Variable | Variable Type | Mean | Standard Deviation | Min | Max |
|---------------------------------|---------------------------------------|---------------|------------|--------------------|--------|--------|
| Dependent Variable | Math Score(PV1) | continuous | 448.51 | 96.56 | 157.03 | 843.42 |
| | Read Score(PV1) | Continuous | 457.03 | 105.90 | 47.32 | 938.68 |
| | Science Score(PV1) | Continuous | 467.69 | 101.65 | 135.84 | 848.69 |
| Core Variables | School Type(Private 1/Public 0) | Categorical | 0.23 | 0.42 | 0.00 | 1.00 |
| School Independent Variable | Socio-economic status of schools(%) | Continuous | 27.98 | 28.19 | 0.00 | 100.00 |
| | teacher with master's degree(%) | Continuous | 22.07 | 25.18 | 0.00 | 100.00 |
| | certificated teacher(%) | Continuous | 83.14 | 32.36 | 0.00 | 100.00 |
| | Shortage of teachers | Continuous | 0.08 | 1.27 | -2.11 | 4.04 |
| | School digital resources | Continuous | 0.03 | 1.01 | -3.11 | 3.77 |
| | Distance education school support | Continuous | 0.16 | 0.95 | -4.17 | 0.85 |
| | Family Control Variables | Family status | Continuous | -0.41 | 1.19 | -6.39 |
| Home digital resources | | Continuous | -0.44 | 1.20 | -5.03 | 5.29 |
| Distance education home support | | Continuous | 0.19 | 1.02 | -2.39 | 2.44 |
| Personal Control Variables | Competence for self-directed learning | Continuous | -0.06 | 0.99 | -2.59 | 2.08 |
| | Personal digital literacy | Continuous | 0.01 | 1.06 | -2.65 | 2.31 |
| | Daily Study Duration | Level | 3.08 | 1.57 | 1.00 | 6.00 |

3 Research Design

3.1 Data Resource

The research data is sourced from the results of the 2022 International Student Assessment Program (PISA) test, which involved 15-year-old high school students from invited countries. The PISA evaluation adopts a two-stage sampling frame. The first stage sampling is to select representative schools for each country considering regional

development level differences; Two stage sampling is the process of selecting students from selected schools. Here, the PISA test assigns the same sampling weight to each sampled school and student. This study will also incorporate this sampling weight into the HLM model to ensure the accuracy of model estimation. And this study selected schools participating in the nationwide implementation of distance education as the survey subjects to examine the teaching quality of private schools in distance education, including 1576 public schools and 22865 students. 483 private schools, including 7016 students.

3.2 Variable Interpretation and Descriptive Statistics

3.2.1. The Dependent Variable.

The dependent variable in this study is academic performance. In this test, each subject is presented with 10 Plausible Values (PV). It uses Project Response Theory (IRT) to estimate the probability distribution of each student's subject testing level, repeatedly estimating the literacy of a certain subject 10 times to form 10 pseudo truth values, and assigning weights to each student's pseudo truth values. If you want to understand the overall literacy level of a student's subject, just look at PV1. To ensure accuracy, the average sum of PV1 is used in descriptive statistics, and the coefficient weighted PV1 value is processed using Restricted Maximum Likelihood Estimation (RMLE) in HLM.

3.2.2 Explanatory Variables.

At the school level, it mainly includes (1) The socio-economic status of the school (the proportion of students from economically disadvantaged families in the sampled schools is SC211Q03JA). (2)Teacher level (STAFFSHORT, PROAT7 for teachers with master's degrees, and PROATCE for teachers with teaching qualifications). (3)School Digital Literacy (DIGPREP for on campus digital resources, SCPREPAP for distance education schools). In terms of family background, it mainly includes(1) Family Digital Literacy (Family Digital Resources ICTRES, Distance Education Family Support FAMSUPSL); (2)(The Family Socio Economic and Cultural Status Index (ESCS) is generated by combining observation variables such as the Family Wealth Index, the highest occupational status index of parents, and the average length of education of parents.And individual factor(1)Self learning competency (SDLEFF); (2) Individual Digital Literacy (ICTEFFIC); (3)The daily learning duration (ST296Q04JA) and the descriptive statistics of each variable are shown in Table 1.

4 Empirical Results

4.1 T-test Results

Table 2 shows that students from private schools perform better in mathematics, reading, and science than those from public schools in distance education (with a difference of about 40 points), and reach a significant level in statistics ($p < 0.001$), indicating that students from private schools do indeed perform better academically.

The student source background of private students is significantly better than that of public schools, as shown in Table 3. The ESCS index of students in private schools is nearly 1 higher than that of public schools. 4 times ($p < 0.001$). Private schools themselves have a selection effect, and children from families with high socio-economic and cultural backgrounds are more willing to choose private schools. At the same time, private students are significantly higher than public school students in terms of family digital resources, remote self-learning competence, and personal digital literacy ($p < 0.001$), indicating that the student background and personal qualities of private schools are far higher than those of public schools.

Table 2. Comparison of academic literacy among students in public and private schools

| Variable | Group | Mean ±Standard Deviation | 95%CI | | T-test |
|---------------|---------|--------------------------|---------|---------|-----------|
| | | | Upper | Lower | t-value |
| Math Score | public | 439.049±94.442 | 440.273 | 437.825 | 30.689*** |
| | private | 479.42±96.95 | 481.685 | 477.146 | |
| Read Score | public | 446.33±103.39 | 447.672 | 444.991 | 31.568*** |
| | private | 491.90±106.49 | 494.367 | 489.412 | |
| Science Score | public | 457.65±99.60 | 458.942 | 456.360 | 31.037*** |
| | private | 500.42±101.37 | 502.793 | 498.047 | |

*** $p < .001$, ** $p < .01$, * $p < .01$

The daily learning time of private students in distance education is not significantly better than that of public schools. In the PISA test, there was no significant difference in the daily learning time between students in public and private schools. This indicates that the achievement of high academic performance in private schools during distance education may not be due to an increase in daily study hours, which contradicts the conclusions of some related studies. [14]Of course, whether this is due to the decrease in daily learning intensity of students in private schools after being separated from school management in distance education deserves further research.

Table 3. Comparison of personal and family characteristics in public and private schools

| Variable | Group | Mean ±Standard Deviation | 95%CI | | T-test |
|---------------------------------------|---------|--------------------------|--------|--------|-----------|
| | | | Upper | Lower | t-value |
| Family status | public | -0.61±1.17 | -0.592 | -0.623 | 59.516*** |
| | private | 0.24±1.00 | 0.264 | 0.217 | |
| Home digital resources | public | -0.67±1.16 | -0.651 | -0.681 | 52.087*** |
| | private | 0.14±1.13 | 0.171 | 0.118 | |
| Distance education home support | public | 0.21±1.03 | 0.221 | 0.194 | -4.75*** |
| | private | 0.14±0.97 | 0.166 | 0.121 | |
| Competence for self-directed learning | public | -0.11±1.00 | -0.099 | -0.112 | 11.866*** |
| | private | 0.05±0.98 | 0.069 | 0.024 | |
| Personal digital literacy | public | -0.04±1.06 | -0.027 | -0.055 | 13.523*** |
| | private | 0.15±1.02 | 0.178 | 0.130 | |
| Daily Study Duration | public | 3.100±1.602 | 3.120 | 3.070 | -2.115 |
| | private | 3.050±1.473 | 3.090 | 3.020 | |

*** $p < .001$, ** $p < .01$, * $p < .01$

As shown in Table 4, in terms of the analysis of differences in teaching staff, the proportion of master's degree teachers and teacher qualification certificate holders in public schools is much higher than that in private schools ($p < 0.001$), and the shortage index of teachers in private schools is also much higher than that in public schools ($p < 0.001$), indicating that the teaching staff of public teachers is much better than that of private schools. But when it comes to school digital literacy, the on campus digital resource index and distance education school support index of private schools are about twice higher than those of public schools ($p < 0.001$), indicating that the digital literacy of private schools is much better than that of public schools. This is consistent with the PISA2022 report that "private school principals are more inclined to report that private schools are prepared for distance learning".

Table 4. Comparison of school characteristics in public and private schools

| Variables | Group | Mean±Standard Deviation | 95%CI | | T-test |
|-----------------------------------|---------|-------------------------|--------|--------|-----------|
| | | | Upper | Lower | t-value |
| Socio-economic status of schools | public | 31.62±28.76 | 33.040 | 30.190 | - |
| | private | 16.09±22.40 | 18.090 | 14.080 | 12.403*** |
| teacher with master's degree | public | 0.23±0.26 | 0.244 | 0.218 | - |
| | private | 0.19±0.20 | 0.205 | 0.169 | -3.936*** |
| certificated teacher | public | 0.84±0.31 | 0.859 | 0.828 | - |
| | private | 0.79±0.36 | 0.825 | 0.761 | -2.287** |
| Shortage of teachers | public | 0.23±1.27 | 0.291 | 0.166 | - |
| | private | -0.42±1.12 | -0.319 | -0.521 | 10.085*** |
| School digital resources | public | -0.02±0.99 | 0.029 | -0.070 | - |
| | private | 0.21±1.02 | 0.304 | 0.121 | 4.455*** |
| Distance education school support | public | -0.021±0.994 | 0.179 | 0.081 | - |
| | private | 0.279±0.774 | 0.348 | 0.209 | 3.431*** |

*** $p < .001$, ** $p < .01$, * $p < .01$

4.2 Analysis of the Multi-layer Linear Model

Further use a multi-layer linear model to explore the differences in literacy scores of civic schools in distance education. The measurement results are shown in Table 5. In the table, (1), (4), and (7) represent the impact of school categories on students' mathematics, reading, and science without controlling for various variables; (2) (5) (8) The net effect of differences in literacy scores between private schools and public schools in distance education, under the control of student background, personal factors, and learning duration; (3) (6) (9) further controls the variables of student background,

personal factors, learning time, and school factors to analyze the differences in literacy scores between private and public schools in distance education. The specific empirical analysis conclusion finds that:

The type of school (public, private) has a lower degree of explanation for student academic performance, as evidenced by the intra group correlation coefficient (ICC) and effect size (f) in the model ² Looking at it, there is a significant difference in the literacy scores of inter school students. The variance variation of the literacy scores of all student samples can be explained by inter school differentiation, which is about 40%. Among them, the difference explained by school type is relatively low, about 10%, and more is explained by the background of school students and personal literacy. After introducing the background of students, their personal qualities, and learning time, it was found that the effect size that can explain the difference in inter school literacy scores is about 40%, which belongs to the effect size with high explanatory validity. Moreover, after adding the factors of school investment and the interaction term of individual self-directed learning competence, the effect size that can explain the difference in inter school literacy scores suddenly increased to about 80%, belonging to a highly explanatory effect size.² Under the control of family background and individual variables of students, the difference in academic performance between public and private school students in distance education decreases, but still remains significantly higher.

Without controlling for student backgrounds and personal qualities, students in private schools scored significantly better in literacy than those in public schools, with math, reading, and science all scoring about 50 points higher. However, after controlling for student backgrounds, private schools are no longer significantly higher than public schools, but the coefficient remains positive and the score difference is still significant (24-32 points), thus supporting hypothesis H1. The impact of a student's family socio-economic and cultural status index, family digital resources, self-directed learning competence, personal digital literacy, and daily learning hours on academic performance is positive. For example, for each unit of improvement in family socio-economic and cultural status index, the student's academic performance in various subjects can be improved by 9-10 points ($p < 0.001$), and for each unit of improvement in self-directed learning competence, the student's academic performance in various subjects can be improved by 7-8 points ($p < 0.001$). However, only the coefficient of family support in distance education is negative, indicating that the higher the level of family support in distance education, the lower the student's academic performance. After incorporating the factors of school investment and all other control variables, it can be found that in distance education, the coefficient of influence of digital resources, teacher qualifications, and master's degree holdings on student performance is negative, especially the master's degree holding coefficient, which has a significant negative impact on student performance. Moreover, for every unit of teacher master's degree increase, students' academic performance in various subjects decreases by 11-38 points ($p < 0.001$). This indicates that in distance education, the more highly educated school teachers there are, the more significant a decrease in student performance will be; It should be noted that although there is data showing that

increasing the number of teacher qualifications by one unit may also result in a 1-6 point decrease in students' grades in various subjects, this effect is not significant.

Among the factors related to distance education, the coefficients of factors related to school investment, such as school distance education support, in school digital resources, and family distance education support, are basically negative, especially the negative impact of the latter two on student performance is very significant ($p < 0.01$). Personal factors that affect distance education performance, such as digital literacy and remote self-directed learning competence, can significantly improve students' academic performance ($p < 0.001$), which supports hypothesis H2. At the same time, adding one unit of household digital resources can also promote students to improve their academic performance in various subjects by 2-3 points ($p < 0.01$).

Table 5. Hierarchical Linear Model (HLM) measurement results

| Explanatory Variables | Math | | |
|--|----------------------|-----------------------|----------------------|
| | (1) | (2) | (3) |
| Intercept | | 446.269*** (2.163) | 404.92*** (8.902) |
| Level 1 | | | |
| Family socioeconomic and cultural status | | 13.086*** (0.523) | 10.281*** (2.012) |
| Home digital resources | | 4.609*** (0.516) | 2.753 (2.078) |
| Distance education home support | | -10.758*** (0.410) | -6.922*** (1.711) |
| Competence for self-directed learning | | 7.422*** (0.433) | 6.782*** (1.755) |
| Personal digital literacy | | 3.746*** (0.398) | 4.407** (1.554) |
| Daily Study Duration | | 2.483*** (0.263) | 5.481*** (0.995) |
| Level 2 | | | |
| School Type | 50.284*** (3.529) | 24.699*** (2.974) | 10.127* (6.653) |
| Socio economic status of schools | | -0.566*** (0.045) | -0.326** (0.108) |
| teacher with master's degree(%) | | | -11.574* (7.257) |
| certificated teacher (%) | | | -6.800 (7.689) |
| Shortage of teachers | | | -4.153* (2.398) |
| School digital resources | | | -9.101** (3.429) |
| Distance education school support | | | 0.961 (2.340) |
| Level1×level2 | | | |
| Distance education school support | | | -2.599* |

| | | | |
|--|----------|----------|---------|
| ×Competence for self-directed learning | | | (1.388) |
| Inter-group variance(τ) | 4073.433 | 2574.951 | 748.452 |
| Intra-group variance(σ^2) | 4593.809 | 4347.370 | 472.268 |
| f ² | 9.83% | 43.00% | 84.14% |
| ICCij | 0.496 | | |

| Explanatory Variables | Read | | |
|--|----------------------|-----------------------|------------------------|
| | (1) | (2) | (3) |
| Intercept | | 446.914*** (2.457) | 411.553*** (10.458) |
| Level 1 | | | |
| Family socioeconomic and cultural status | | 12.026*** (0.592) | 9.669*** (2.262) |
| Home digital resources | | 4.730*** (0.584) | 3.470* (2.331) |
| Distance education home support | | -12.606*** (0.464) | -6.711*** (1.918) |
| Competence for self-directed learning | | 8.934*** (0.490) | 12.434*** (1.968) |
| Personal digital literacy | | 5.928*** (0.450) | 7.044*** (1.743) |
| Daily Study Duration | | 4.470*** (0.298) | 6.932*** (1.116) |
| Level 2 | | | |
| School Type | 53.743*** (3.910) | 29.843*** (3.380) | 32.771*** (7.908) |
| Socio economic status of schools | | -0.363*** (0.052) | -0.355** (0.052) |
| teacher with master's degree(%) | | | -38.747*** (8.611) |
| certificated teacher (%) | | | -1.510 (9.124) |
| Shortage of teachers | | | 1.875 (2.840) |
| School digital resources | | | -12.695** (4.075) |
| Distance education school support | | | -0.780 (1.561) |
| Level1×level2 | | | |
| Distance education school support ×Competence for self-directed learning | | | - 1.128(1.556) |
| Inter-group variance(τ) | 4975.723 | 3330.972 | 1147.693 |
| Intra-group variance(σ^2) | 5876.532 | 5558.736 | 5899.405 |
| f ² | 9.41% | 39.36% | 80.55% |
| ICCij | 0.483 | | |

| Explanatory Variables | Science | | |
|--|----------------------|-----------------------|------------------------|
| | (1) | (2) | (3) |
| Intercept | | 459.339*** (2.295) | 422.870*** (10.030) |
| Level 1 | | | |
| Family socioeconomic and cultural status | | 14.219*** (0.575) | 9.389*** (2.164) |
| Home digital resources | | 3.164*** (0.567) | 3.618* (2.231) |
| Distance education home support | | -11.773*** (0.451) | -3.891** (1.836) |
| Competence for self-directed learning | | 7.422*** (0.476) | 8.852*** (1.668) |
| Personal digital literacy | | 4.672*** (0.437) | 6.474 (0.450) |
| Daily Study Duration | | 3.816*** (0.290) | 6.602*** (1.068) |
| Level 2 | | | |
| School Type | 53.324*** (3.650) | 28.715*** (3.135) | 23.008*** (7.588) |
| Socio economic status of schools | | -0.402*** (0.048) | -0.366** (0.123) |
| teacher with master's degree(%) | | | -33.960*** (8.262) |
| certificated teacher (%) | | | - 4.178(8.755) |
| Shortage of teachers | | | - 0.703(1.089) |
| School digital resources | | | -9.761** (3.910) |
| Distance education school support | | | -1.829 (2.661) |
| Level1×level2 | | | |
| Distance education school support ×Competence for self-directed learning | | | -2.736* (1.489) |
| Inter-group variance(τ) | 4296.63 | 2818.639 | 1060.633 |
| Intra-group variance(σ^2) | 5548.294 | 5265.712 | 5399.828 |
| f^2 | 10.40% | 41.22% | 80.36% |
| ICC _{ij} | 0.464 | | |

①inside“ () ”is Standard error of coefficient.

②Null model : $\tau(\text{math})=4517.375, \sigma^2(\text{math})=4595.055. \tau(\text{read})=5492.629, \sigma^2(\text{read})=5877. \tau(\text{science})=4795.216, \sigma^2(\text{science})=5550.009.$

③* $p < 0.1$, ** $p < 0.01$, *** $p < 0.001$.

4.3 Robustness Testing

To test for bias in the above results, the study further used propensity score matching (PSM) to test the robustness of the results. The test results (Table 6) show that the standard deviation of the matched variables is much less than 10%, and the error is eliminated by nearly 90%. The t-test results do not reject the null hypothesis that there is no systematic difference between the treatment group and the control group. This indicates that the propensity scores of the two groups are matched, passing the balance test, and the matching effect is good, meeting the statistical homogeneity requirements.

Table 6. Balance test after sample matching

| Matching Variables | Pro- cessing Effect | Mean | | Standard devia- tion(%) | Standard devia- tion(%) | t | p |
|--|---------------------------|-------------|--------------|-------------------------------|-------------------------------|-------|-------|
| | | Pub- lic | Pri- vate | | | | |
| Daily Study Duration | Un- matched | 3.095 | 3.051 | -2.8 | 74.4 | -2.02 | 0.043 |
| | Matched | 3.040 | 3.051 | 0.7 | | 0.43 | 0.665 |
| Distance edu- cation home support | Un- matched | 0.207 | 0.143 | -6.4 | 91.6 | -4.60 | 0.000 |
| | Matched | 0.149 | 0.143 | -0.5 | | -0.32 | 0.750 |
| Competence for self-di- rected learn- ing | Un- matched | - 0.112 | 0.046 | 16.1 | 97.3 | 11.74 | 0.000 |
| | Matched | 0.042 | 0.046 | 0.4 | | 0.25 | 0.802 |
| Home digital resources | Un- matched | - 0.666 | 0.144 | 70.6 | 97.9 | 51.39 | 0.000 |
| | Matched | 0.161 | 0.144 | -1.5 | | -0.88 | 0.378 |
| Family socio- economic and cultural status | Un- matched | - 0.608 | 0.240 | 77.7 | 98.9 | 54.69 | 0.000 |
| | Matched | 0.231 | 0.240 | 0.8 | | 0.55 | 0.585 |

After constructing the counterfactual distribution sequence of student grades for matching samples, the propensity matching estimation of the processing effect of private and public schools was conducted (Table 7), which is consistent with the multi-layer linear model. That is to say, before matching, students from private schools scored significantly higher than those from public schools ($t > 1.96$), and after matching, the bias ratios of variables involved in matching were significantly reduced. However, students from private schools in various subjects still scored significantly higher than those from public schools (Mathematics ATT=7.510, Reading ATT=11.384, Science APP=10.789, $t > 1.96$). This verification supports the estimation results of the multi-layer linear model mentioned earlier, verifies its robustness, and also verifies H1.

Table 7. Propensity Score Matching (PSM) estimation results

| subject | sample | Mean | | Difference | standard deviation | t |
|---------|-----------|---------|---------|------------|--------------------|-------|
| | | Public | Private | | | |
| Math | Unmatched | 439.048 | 479.415 | 40.367 | 1.297 | 31.12 |
| | ATT | 471.905 | 479.415 | 7.510 | 1.944 | 2.96 |
| Read | Unmatched | 446.331 | 491.904 | 45.573 | 1.421 | 32.07 |
| | ATT | 480.519 | 491.904 | 11.384 | 2.122 | 4.53 |
| Science | Unmatched | 457.651 | 500.420 | 42.769 | 1.365 | 31.33 |
| | ATT | 489.632 | 500.420 | 10.789 | 2.062 | 4.22 |

5 Discussion

In this study, hypothesis 1 was supported, indicating that the average grades of students in private schools who implemented distance education under the control of student background and individual characteristics were still significantly higher than those in public schools. This indicates that private schools have their own unique advantages in running schools. Assumption 2 is also supported, indicating that the level of academic performance in distance education depends more on the individual qualities of students rather than the factors invested by the school. Therefore, both public and private schools need to explore in depth how to enhance students' personal qualities in order to bring about a significant improvement in academic performance.

6 Conclusion

Firstly, in distance education, private schools have significantly better academic performance than public schools. Moreover, the higher the socio-economic and cultural status of student families, the more likely they are to choose private schools for education, which is supported by the descriptive statistics of the socio-economic status of private and public schools. And in distance education, the main reason why private schools have higher academic performance than public schools is that students have excellent personal digital literacy and self-learning abilities due to their excellent student backgrounds, rather than the length of learning time and the investment of home and school in distance education. Although private schools do provide much better digital resources than public schools.

Secondly, in secondary distance education, cultivating students' personal digital literacy and remote self-directed learning ability can better improve the teaching quality of distance education compared to factors invested by families and schools. In this study, the teaching staff of private schools were not as good as those of public schools, but the teaching performance of private schools was significantly higher than that of public schools. Moreover, when implementing distance education, excellent teaching staff did not bring about an improvement in grades, but instead led to a decrease in grades; Moreover, family support in distance education significantly leads to a decline in student academic performance, and these issues are worth pondering. We don't know if there will be any unexpected events in the future world that will lead to the large-

scale implementation of secondary distance education. In order to "suspend classes without stopping learning" and for middle school students to independently engage in various personalized distance education in their daily learning, both private and public schools should attach importance to cooperation with their families and schools, focusing on improving students' personal digital literacy and remote autonomous learning ability, enhancing the utilization of various resources, and laying the foundation for future learning.

Reference

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