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Effective investment strategies on mathematics performance in rural areas

Abstract

Taiwan has noticed relative disadvantages in rural areas and offered more scholarship opportunities for aboriginal and low-income students. Moreover, the Educational Priority Area program was implemented in 1996 to invest additional funds in rural schools. Although the average mathematics ability of Taiwanese students ranks high in the Programme for International Student Assessment (PISA), the cost-benefit outcome of government funding in rural areas is inadequate. This paper , therefore, tries to explain low student achievement in rural areas with the multilevel modeling (HLM). Data were gathered from 5,581 Taiwanese students in 236 junior high schools using stratified random sampling. Of the data, 2,358 students from 112 rural area schools and 3,223 students from 124 non-rural area schools were sampled. The results demonstrate the importance of distinguishing between resources and investments, and shifts focus from comparisons of the influence of families and schools preexisting conditions to discussions of improvement strategies on mathematics performance. Both families and schools are limited by their resources, but the findings presented in this study suggest that families and schools can improve student achievement with appropriate investments.

Keywords: resource-investment model; rurality; mathematics education

Introduction

Rural areas are usually characterized by inconvenient transportation and a population of high-poverty or minority students. Moreover, economic, geographic, physical, and social disadvantages in these areas result in the isolation of rural locations from other areas (Webster and Fisher, 2000). Young (1998) discovered that school location was the main factor affecting student achievement levels, especially math scores. With samples from Western Australia, Young determined that location could explain 37.6% variance between schools and argued that students in rural areas demonstrated low socioeconomic status (SES) and student achievement. Furthermore, students in rural areas had higher dropout rates and were taught by less qualified teachers (Mitchem, Kossar, and Ludlow, 2006; Roscigno and Crowley, 2001). Scholars found low student achievement especially noteworthy because students' scores not only demonstrated the quality of their education, they also had a decisive effect on student income in the future (Lee and Barro, 2001). According to 2006 math scores from PISA, low grades for rural students may be a problem in countries other than Australia and the United States as well. Although the average mathematics ability of Taiwanese students ranked high in PISA 2006, Taiwan may face even greater problems with low scores for rural students than other areas. Table 1 shows that rural (village) students in Taiwan have substantially lower math scores than their counterparts in small and large cities. These students also show higher variance than other students in Taiwan and even other countries, suggesting large score differences among rural students.

[Insert Table 1 here]

Numerous researchers are concerned with low student achievement in rural areas and have attempted to develop approaches for improving student scores. Behrman, Khan, Ross, and Sabot (1997) indicated that school inputs, such as school equipment and infrastructures, had little influence on student achievement in rural Pakistan. Instead, teacher quality and student exposure to teachers were more essential to improving achievement. They further recommended that investment in schools should focus on teacher quality rather than school facilities. Webster and Fisher's (2000) study provided similar results. They used the Trends in International Mathematics and Science Study (TIMSS) database to investigate resource availability in rural and urban Australian schools and discovered that school resources had no influence on math and science scores. However, Daley, Whaley, Sigman, and Guthrie (2005) found that both physical and teacher qualities were positively correlated with arithmetic scores in rural Kenya.

Researchers studying rural student achievement tend to use "school input," "school resources," and "school quality" to represent school conditions. However, these studies fail to integrate categories that can be improved with those that cannot, and, consequently, fail to provide rural schools and students with useful strategies for improvement. For example, Behrman et al. (1997) determined that the cognitive achievement of teachers in mathematics, the educational attainment of teachers, and experience were proxy variables for teacher quality, but it is difficult to improve these variables. Daley et al. (2005) showed a similar problem. In their paper, Daley et al.

(2005) provided only one indicator (teacher organization of classrooms) of four that could actually be improved. In addition, most researchers focus on indirect measures of the influence of investments on student achievement. For instance, Behrman et al. (1997) failed to design proper investment categories based on student achievement. As a result, although toilets for students demonstrated a positive effect on math scores, this phenomenon could simply imply that schools needed adequate facilities. Webster and Fisher's (2000) paper does not demonstrate the weaknesses found in other works on student achievement, but it failed to explain that school facilities have little effect on student achievement. Webster and Fisher's (2000) research may demonstrate this shortcoming because it combines resources and investments as one entity.

Roscigno and Crowley (2001) revealed that integrating resources and investments blurred potential effects; therefore, they developed a resource investment model to analyze low student achievement in rural areas. Their results were disappointing, however, because they were unable to provide useful investment strategies and focused on whether resources and investments could explain differences in student achievement in rural and non-rural areas. However, as Pegg and Panizzon (2007) stated, rural students require educational strategies that do not simply describe their situation but can also help them improve their approaches to learning. Our paper explains the reasons for low student achievement in rural areas and provides useful strategies for schools and families. To achieve this goal, the paper extends a resource investment model derived from Roscigno and Crowley (2001) and Roscigno, Tomaskovic-Devey, and Crowley (2006), and adopts this model to analyze the effects of investments and resources on student achievement in rural and non-rural subsamples. The non-rural subsample serves as the control group in this study and is used to understand low student achievement in rural areas and the reasons school and family investment have little effect on student achievement.

The remainder of this paper is organized as follows. First, a resource investment model is introduced, and investment indicators are discussed. Method and data analysis is followed by a literature review. The final section offers discussions and suggestions.

The resource investment model

Because student achievement is the result of a resource operation, it is important to first discover resources that have a positive effect on achievement. Roscigno and Crowley (2001) further argued that resources should be separated from investments to enhance the focus on institutional processes and their innate characteristics. They also believed that rurality had a direct influence on investments, resources, and educational outcomes because school boards have the ability to invest resources in schools. Roscigno and Crowley (2001: 276) measured family resources using family SES (parental income and education) and structure (marital status of parents and number of siblings). Family investments were represented by household items related to learning, the cultivation of cultural capital (through cultural trips, e.g., museum visits and classes such as art and music), and parental expectations. School resources were measured using class and racial composition as well as per pupil expenditure, and were then interpreted as school conditions, including class size, student-teacher ratio, and teacher expectations. The main dependent variables were math- and reading-score

averages and dropout status. Roscigno and Crowley (2001) discovered that rural high school students in the United States had access to fewer family and school resources and investments than their non-rural counterparts, which accounted for lower achievement for rural students.

Five years after the Roscigno and Crowley (2001) paper, Roscigno, Tomaskovic-Devey, and Crowley (2006) followed the structure established in the initial study to interpret advantages and disadvantages in different areas and their roles in producing or even reproducing the inequalities discovered in the first study. However, Roscigno, Tomaskovic-Devey, and Crowley (2006) replaced parent and teacher expectations with parental involvement and teacher encouragement, respectively. They also divided non-rural areas into inner cities and suburban districts. Similarly to Roscigno and Crowley (2001), Roscigno, Tomaskovic-Devey, and Crowley (2006) focused on decreases in coefficient magnitude for rurality variables to reflect the extent to which deficits in educational investment in different areas were a function of regional variations in available resources. The results of the study revealed that resources could be transformed into investments and could explain differences in student achievement levels.

This study maintains that investments should be considered separately from resources and that this distinction can improve observations of investment decisions made by families and schools because of the limits of available resources (Roscigno, Tomaskovic-Devey, and Crowley, 2006: 2121). However, Roscigno, Tomaskovic-Devey, and Crowley (2006) failed to determine which investments and resources exercised important influences on rural and non-rural student achievement. In addition, the study's distinction between resources and investments was not completely clear. In their study, Roscigno and Crowley (2001) combined investments with psychological variables such as parent and teacher expectations. However, when families and schools emphasize student learning, they invest more in activities or items related to learning and less in the psychological status of students (Wobmann, 2003).

Studies relevant to student achievement should first provide exact definitions of "resources" and "investments." Adopting the resource investment model, this study defines "resources" as preexisting conditions (including economic support) that can be used to purchase facilities or hire teachers. "Resources" are also represented by student characteristics in a school and SES in a family. Schools and families find it difficult to change these preexisting conditions, and categorization according to preexisting school conditions was even previously implemented in South Carolina to separate schools into different bands (Richards and Sheu, 1992). "Investments" refer to facilities developed from resources or activities devised using resources. This distinction between resources and investments indicates that the effects of investments may be limited by resources. In other words, when they are not coupled with resources such as stable working conditions for teachers and adequate finances, investments may have little influence on student achievement.

Useful investments for student achievement

Distinguishing between resources and investments promotes the discovery of

investment strategies that can improve student achievement and improves observations of how investments affect student achievement. These strategies also represent effective uses of money (Odden and Picus, 2007). Nevertheless, understandings of how investments affect student achievement are difficult to achieve because investments can develop inside or outside the household (Shapiro and Tambashe, 2001). Therefore, investment sources should be divided between families and schools when discussing the influence of investments on student achievement.

Family investments are usually directly linked to the concept of parental involvement because parents are the main source of economic and physiological support in a child's life and parents care for their children by becoming more involved in their studies or student activities (Ho and Willms, 1996). However, the connection between parental involvement and student achievement is inconsistent because of the diverse conceptualizations of parental involvement created by scholars and society. In light of this phenomenon, McNeal (2001) divided parental involvement into four categories: parent-child discussion, parent-teacher organization, parental monitoring, and educational support strategies. McNeal discovered that, whereas parent-teacher organization, parental monitoring, and educational support strategies had little influence on achievement but contributed to lower levels of student misbehavior (such as truancy and failure to complete school), parent-child discussion had a positive effect on student achievement. Although educational support strategies indicated no effect on student achievement in his research, McNeal (2001) argued that these strategies were the most direct form of parental involvement in the schooling process. If discussion between parents and children could be viewed as an investment of time, educational support strategies could then represent a material investment, and various material investment strategies could exist in different cultures. For example, numerous children in Taiwan attend afterschool tutorials or cram schools. These schools are the main approach parents use to help their children improve in school, especially in subjects parents are less proficient in such as math. Several researchers (Lee, 2007; Lin and Hwang, 2009) have also discovered that afterschool tutorials and cram schools have a positive effect on student achievement. Another useful investment strategy is learning environment arrangement. Researchers (Teachman, 1987; Roscigno, Tomaskovic-Devey, and Crowley, 2006; Charles, Roscigno, and Torres, 2007) have selected learning material variables, such as reference books, computers, places to study, and dictionaries or encyclopedias, to test the influence of these variables on student achievement.

Schools can invest in at least four categories: teaching facilities, books, professional development for teachers, and student activities. Facilities, especially computer-based facilities, such as computers and electronic blackboards, have become popular in recent educational instruction. Barrow, Markman, and Rouse (2008) found that computer-assisted instruction had a positive effect on student achievement in math. Books are major sources for learning, especially in rural schools where teaching staffs are insufficient. Daley et al. (2005) indicated that the number of books in a school and the quality of these books were positively related to the arithmetic scores achieved by rural schoolchildren in Kenya. Another crucial type of investment is professional development for teachers. In this complex and rapidly changing era, teachers require more training and discussion with their peers to handle teaching problems adequately, and investment in professional development positively affects math scores (Saxe, Gearhart, and Nasir, 2001). Professional development for teachers is especially

important to rural students because it can be designed exclusively for use in rural schools. Hamm et al. (2010) explained that professional development helped teachers gain the knowledge and experience they required to handle specific rural conditions. In addition, schools usually organize speeches and hold sporting events to vary study routines and reduce student stress levels. Extracurricular activities allow students to develop their own interests and identities and provide physical and mental stimulus (Caskey, 2006). Zaff, Moore, Papillo, and Williams (2003) also discovered that extracurricular activities had a persistent influence on academic achievement for students from the 8th to 12th grades.

Data

The number of surveyed schools for different groups was made as equal as possible to improve comparisons between rural and non-rural schools. Data were gathered from 5,581 Taiwanese students in 236 junior high schools using stratified random sampling. Of the data, 2,358 students from 112 rural area schools and 3,223 students from 124 non-rural area schools were sampled. Rural schools were chosen from a database where counties reported relevant information. Standards for rural schools include various factors that are more complicated than those adopted by PISA (PISA uses only population density), such as the distance of the school from the city, amounts of aboriginal students, and population density. The number of students in a school (group size) ranges from 6 to 35, which yields enough valid responses for a multilevel analysis (Maas and Hox, 2005).

Methods

Previous studies, especially those on production functions, argued whether the student or the school was the proper level to analyze. However, these studies often focused their attention on the wrong issue because of their data structure and the multilevel modeling (HLM) they adopted (Willms and Somers, 2001). A modified notation based on Ma, Ma, and Bradley (2008), the HLM model with grand-mean centering used in this study can be defined as follows:

$$
\begin{aligned}
&Y_{ij} = \beta_{0j} + \sum_{p=1}^{P} \beta_{pj} Family\_resource_{pij} + \sum_{q=1}^{Q} \beta_{qj} Family\_investment_{qij} + r_{ij} \\
&\beta_{0j} = \gamma_{00} + \sum_{r=1}^{R} \beta_{0r} School\_resource_{rj} + \sum_{s=1}^{S} \beta_{0s} School\_investment_{sj} + u_{oj} \\
&\beta_{1j} = \gamma_{10} \\
&\beta_{2j} = \gamma_{20} \\
&\ldots\ldots \\
&\beta_{(P+Q)j} = \gamma_{(P+Q)0}
\end{aligned}
\tag{1}
$$

where $family\_resource_{pij}$ and $family\_investment_{qij}$ are student level variables, and $school\_resource_{rj}$ and $school\_investment_{sj}$ are school level variables. Four variables exist, and each variable contains four indicators that have been inputted into the

model to test variable and indicator interactions and compare effects on math achievement in rural and non-rural locations. This procedure also confirms that school and family investments can be applied to all schools and families because resources for both groups can be controlled (Ma, Ma, and Bradley, 2008).

Two proportional reductions in variance are provided based on different variance levels to determine which proportional reductions in variance can be attributed to the four variables (McCoach and Black, 2008) and to identify which variables should be prioritized for improvement. The proportion of between-school variance explained by the student model can be defined as

$$\frac{\tau_{00(null)} - \tau_{00(fitted)}}{\tau_{00(null)}} \tag{2}$$

where $\tau_{00(\text{null})}$ is the between-school variance without any variables, and $\tau_{00(\text{fitted})}$ is the between-school variance for the fitted model with variables in Formula 1.

The proportion of within-school variance in the intercepts explained by the student model can be defined as

$$\frac{\sigma^2_{00(null)} - \sigma^2_{00(fitted)}}{\sigma^2_{00(null)}} \tag{3}$$

where $\sigma^2_{00(\text{null})}$ is the within-school variance without any variables, and $\sigma^2_{00(\text{fitted})}$ is the within-school variance for the fitted model with variables in Formula 1.

Measurement

The resource and investment indicators adopted in this study were collected mainly from PISA and TIMSS (the most famous international education surveys to date) and indicators used in previous research. Meetings were also held to confirm that chosen indicators conformed to conditions in Taiwan. Because this study defines a “resource” as a preexisting condition, it considers SES and family structure important family resources. Parental education and occupation are used as SES indicators, and number of siblings and single parent status represent family structure. At the school level, teachers are seen as the core resource promoting student achievement, and they generally require at least five years of teaching experience to effectively improve achievement (Rivkin, Hanushek, and Kain, 2005). Consequently, schools require experienced teachers and stable personnel structure. In this paper, teacher seniority represents teacher quality and teacher mobility rates indicate school stability. In Taiwan, schools have little authority to raise teacher salaries or provide other substantial subsidies to attract teachers to their institutions. Teacher seniority and teacher mobility rates are therefore considered school resources, or, preexisting conditions at schools. Per pupil expenditure is coordinated mainly by the government and is also seen as a preexisting condition. Finally, the amount of aboriginal students in a school indicates student characteristics, which is also a preexisting condition and school resource.

The approaches for measuring investments adopted in this paper are different from those used in previous studies, which determined the number of items possessed by

students or schools to calculate investment scores. In this paper, family and school investments are evaluated by students and teachers, respectively, because students and teachers use these investments most frequently. The evaluation scale ranges from 0 (*none*) to 6 (*high quality*). It measures family and school investment qualities and differentiates the quality of each investment.

Not every indicator is represented in the study's models, and several factors are classified through principal component analysis with promax rotation. Based on the literature review and the results of principal component analysis, family investment indicators can be classified as technological facilities, learning environments, parental discussions, and afterschool math tutorials. School investment indicators can be categorized as teaching facilities, books, student activities, and professional development. A detailed definition of variables is presented in the appendix.

Results

Table 2 displays comparisons of student achievement, resources, and investments in rural and non-rural areas. The table shows that students in rural areas are at a relative disadvantage in the categories of student achievement, SES, and family investment. The parents of rural students earn less money and receive less education than their non-rural counterparts with the possible result that they obtain lower quality investments for their children (as Table 2 demonstrates). Although per pupil expenditure in rural areas is higher than in non-rural areas, rural schools face disadvantaged student rates three times greater than those seen in non-rural schools. However, rural schools possess higher-quality investments. Rural schools maintain higher-quality technological facilities and student activities, and no significant difference exists in book quality between rural and non-rural areas. However, the quality of professional development in rural areas is relatively low, possibly because high-quality teacher programs are harder to develop in these areas. The right-hand side of Table 2 displays correlations between rural and non-rural areas, demonstrating that most of the relationships between independent variables are moderate (below 0.7).

[Insert Table 2 here]

School effect

Table 3 shows that, in rural areas, per pupil expenditure, teacher mobility rates, and amounts of aboriginal students have a negative effect on math achievement, whereas teacher seniority has a positive effect. These effects continue to exist even when school investments are controlled, but teacher seniority ceases to have an influence in non-rural areas when school investments are constant. Because funding appropriations in Taiwan are based on classes and not students, large schools, which are usually more famous than smaller ones, can absorb greater numbers of students and form larger classes, resulting in low per pupil expenditure and high student achievement at large schools. This outcome, which is complex and difficult to explain, is discussed in the next section (Table 4).

School investments have a significant effect on math achievement in non-rural areas; however, aside from professional development, they have no influence in rural areas. Nevertheless, the influence of professional development on rural student achievement disappears after school resources are rendered constant, suggesting that rural school investments are affected by school resources. By contrast, the significance of non-rural school investments remains unchanged in Model 3. In non-rural areas, the quality of technological facilities and professional development has a positive effect on math scores, but the quality of student activities has a negative effect. This negative effect may indicate that activities distract students from their studies.

After determining the effects of different resources and investments on math scores, the overall influence of these factors can be analyzed using the percentages of school and student variance explained by different variables displayed in the bottom of Table 3. Models 1 and 2 show that rural schools are significantly affected by resources because the variance attributed to resources for rural schools is at least twice that for non-rural schools (30.38 vs. 12.41). Moreover, in rural areas, school investments have much less of an influence on school variance than school resources (1.31 vs. 30.38). By contrast, non-rural schools are slightly more affected by school investments, suggesting that, with the right investments, schools can improve student learning, even when limited by school resources.

[Insert Table 3 here]

The negative effect of per pupil expenditure on math scores is presented in Table 4, demonstrating that, as funding per student shares increases, student math grades decrease. This phenomenon may be caused by a special Taiwanese financial allocation system that bases itself mainly on class number rather than student number. Table 4 is divided according to location and class number to offer more information. The table demonstrates that, when schools have more classes, their per pupil expenditure decreases. Although schools with more classes may receive more funding, they have larger class sizes as well. Increases in funding fall substantially below student growth.

However, larger schools are able to hire and retain better teachers, and they also attract students with higher SES and better grades than those in small schools. This situation leads to the negative effect of per pupil expenditure on math scores. However, as Holmlund, McNally, and Viarengo (2010) stated, a multiple-year database (which most general studies cannot provide) is required to better understand the relationship between per pupil expenditure and student achievement. The topic therefore warrants further research. This study retains per pupil expenditure in its model to control for school resources.

[Insert Table 4 here]

Family effect

As Table 5 indicates, the influence of non-rural parental employment on student achievement is significant, but its effects disappear after controlling for family investments. This outcome is not surprising because parental employment is a proxy for family income and its effects can be negated by substantial investments. In addition, although Blake's (1985) dilution of resources hypothesis is not supported in non-rural areas, the addition of one sibling in rural areas contribute to a decrease in math scores of 0.89. Students living with only one parent or no parents have lower math scores than their counterparts with two parents. After controlling for family investments, the difference between single- or no-parent and two-parent families can be reduced from 3.43 and 6.52 to 2.24 and 4.57 in rural and non-rural areas, respectively.

In Model 5, all family investments, except for parental discussion, demonstrate a significant effect on math scores, but the effects of technological facilities in rural areas disappeared after controlling for family resources. The quality of non-rural technological facilities had a negative effect on scores, even when family resources were constant, which suggests that overinvestment leads to lower math achievement. Non-rural families can purchase high-quality computers with high-speed CPUs and Internet. However, this equipment can also be used to play online games or browse Web pages, which may encroach on students' study time. Although parental discussion has no significant effect on math scores, the correlation between discussions and scores is significant (0.19 and 0.22 in rural and non-rural areas, respectively), which indicates that the effects of parental discussion are shared by other investments. Parents should therefore pay more attention to their children.

The influence exercised by family resources and investments can also be compared using explained school and student variance rates, which demonstrate that family investments have more influence than resources. The between-school variability attributed to rural family investments is 29.34%, whereas only 18.83% of between-school variability is explained by rural family resources. Although more non-rural school variance is attributed to family resources than to family investments (30.96 vs. 30.83), more student variance is attributed to family investments than to family resources in both rural and non-rural areas.

[Insert Table 5 here]

School and family effect

Table 6 displays coefficient difference tests between rural and non-rural areas and coefficient change after controlling for four variables. All variables demonstrate a statistically significant difference between rural and non-rural student achievement, suggesting that the effect (slope) of resources and investments on math scores is conditional on rurality. Rural school investments have no significant influence on student achievement, and Tables 3 and 4 (and related discussions) show that any influence rural school investments have are negated by school resources. In contrast, three school investments have significant effects on student achievement in non-rural areas, but their effects have decreased from between 1 and 3 marginal points. In addition, school resources (except for per pupil expenditure) exercise a persistent effect in rural areas, whereas only the amount of aboriginal students has a significant effect in non-rural areas. This phenomenon indicates that rural areas are affected more significantly by school resources than non-rural locations.

The failure of rural school investments to improve student achievement should be solved by greater family investments, or rural student achievement will remain at a low level. Unfortunately, although the significance of family investments is constant, these investments have less of an effect on rural student achievement than on non-rural achievement. The differences in coefficients for learning environments and afterschool math tutorials are 0.31 and 0.06 points, respectively. Rural student achievement is also less affected by family resources than non-rural student achievement. Only one variable, sibling number, affects rural areas more significantly than non-rural ones.

[Insert Table 6 here]

Discussion

This study focuses on the effects of school and family investments on math scores in rural and non-rural areas. The conclusions provided in the study confirm previous findings that rurality mediates the relationship between school investments and student achievement (Roscigno and Crowley, 2001; Roscigno, Tomaskovic-Devey, and Crowley, 2006; Young, 1998). This study, however, offers further explanations of the reasons school investments have little effect on math scores and provides a comparison of the influence of investments in rural and non-rural schools. Of the four school investment indicators, only the quality of professional development had any effect on math scores in rural areas. This finding supports the suggestion made by Hamm et al. (2010) that professional development can make a salient contribution to achievement for rural students. Nonetheless, other school investments have no significant influence on math scores, which contradicts results presented in previous studies (Barrow, Markman, and Rouse 2008; Daley et al., 2005; Zaff et al., 2003). The reason for this discrepancy may be that previous studies neglected school resources, which would affect their outcomes because the influence of professional development on achievement disappears after school resources are held constant. Moreover, the school variance explained by rural school resources is substantially higher than that explained by non-rural school resources (30.38 vs. 12.41). These findings indicate that rural schools are deeply affected by school resources and find it difficult to improve math scores through investments. Additionally, the negligible effects of rural school investments may imply overinvestment because Table 2 shows that investment quality for rural schools is better than that for non-rural institutions, but rural schools still demonstrate lower student achievement. This result suggests that the focus of achievement studies should shift from school investments to school resources, especially in discussions of rural schools. Although conditions in rural and non-rural areas cannot be rendered completely equal, governments can still improve key school resources, such as teacher mobility rates and teacher seniority, to stabilize personnel, attract more experienced teachers, and draw more attention to aboriginal students.

For rural families, the results of this study confirm most of the useful investment indicators adopted in previous research. The study also demonstrates that family investments have higher school variance and student explained variance rates than family resources, implying that parents can use appropriate investments to make substantial improvements in their children's achievement levels, regardless of preexisting conditions. These parents can develop better learning environments, such as those in non-rural areas, which can improve student achievement levels. Regarding the government, it can transform reward systems for students (especially aboriginal students) so that these systems provide learning materials, such as desks and reference books, instead of scholarships. For their part, non-rural families should reduce their investments in technological facilities and focus more on learning environments.

This paper's discovery that parental discussion has a negligible effect on student

achievement differs from McNeal's (2001) findings. Parental discussion may have little influence because its effects are common to other family investments. Therefore, the insignificant effect of family discussion does not mean that parents should pay less attention to their children but indicates that they should invest substantial time and resources in their children's education. The positive effects of afterschool math tutorials may also represent a warning that family spending and school education are insufficient. Participating in math tutorials not only requires parents to spend more money on their children (a poor family may be unable to afford this expenditure), it also suggests that children do not receive enough education in school. Schools can review textbooks and teaching methods to help students, especially those without access to math tutorials. Schools can also teach parents how to better develop learning environments. In other words, if schools and families fail to work collaboratively, efforts made in schools may be hindered in the household (and vice versa).

Limitations

The relationship between variables is complex. This paper compares four influences on student achievement—family resources, family investments, school resources, and school investments—with explained variance rates. However, these comparisons may be subject to limitations. When comparisons on the influences of resources and investments are conducted, indicator selection may affect comparison results. For example, the amount of aboriginal students in a school, which has demonstrated a powerful effect on student achievement in previous research, can be classified as a school resource or a family resource. It is categorized as a school resource in this study for two reasons. First, the amount of aboriginal students in a school is an important index for government grants. Second, this study attempts to determine whether school investment can have a greater influence on student achievement than school resources. Although school investment was found to be less influential than school resources in rural areas, non-rural school investments demonstrated a greater effect on student achievement than resources.

Conclusion

Previous educational studies have been less concerned with schools and students in rural areas and have rarely compared these schools and students to their counterparts in non-rural areas. This practice has created the myth that investment strategies in rural and non-rural areas are similar. However, this paper offers a different perspective, that is, the educational return on resources and investments actually varies by context. Because of massive funding recently allocated to rural schools, investments in rural schools are similar to those in non-rural schools and even exceed those in non-rural schools in the areas of technological facilities and student activities. Nevertheless, the return on these investments is disappointing. School-level investments create no significant improvement in achievement for rural students, whereas at least two investments have a positive effect on non-rural students. The teacher mobility rate is 7.56% in rural schools, almost double the rate found in non-rural institutions. Rural schools also have less experienced teachers than non-rural schools. Although rural schools possess higher quality

investments, without stable and experienced personnel, they can do little to improve student achievement. This conclusion is supported by the higher variance rate explained by school resources than by school investments. Resource and investment disparities at the family level, as discussed by Roscigno and Crowley (2001), can also explain disappointing returns on investments in rural areas. Students in rural areas are relatively disadvantaged. The parents of these students receive less education and earn less money than their non-rural counterparts, and even their discussions with their children cannot positively affect math achievement levels. The effects of increases in school resources and investments may be restricted because of family conditions.

This paper also demonstrates the necessity of distinguishing between resources and investments, shifting the focus of student achievement research from comparisons between the influence of families and schools to discussions of preexisting conditions and improvement strategies. Both families and schools are limited by their resources, but this study's findings suggest that families and schools can improve student achievement levels through appropriate investments. Although families still have a greater effect on students than schools, schools are responsible for teaching parents how to enhance a child's learning environment. Only by adopting this approach can families and schools cooperate to improve education, regardless of where a student lives. This discovery has the potential to inaugurate a new field of research on the influence of families and schools that does not compare the effects of the two but instead offers useful strategies for improvement, especially in poorer areas.

Appendix

[Insert Table 7 here]

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