Present status of school facilities and its prospects in future in the Republic of the Union of Myanmar

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Abstract

Looking at the distribution of schools from the number of students, there were many extremely small schools where the number of students was less than 100. If the school is too small, it is difficult to make even a principal's office and a teachers' room as well as special rooms for quality education such as a library, a computer room, a laboratory, a LL, etc. The small size of the school prevents effective and efficient use of school buildings.

From the results of the regression analyses, schools with good access and close to TEO (Township Education Office) as well as established schools had a high proportion of special rooms. The previous analyses showed that the number and quality of teachers in these schools were high, and educational conditions were also better in terms of facility. Differing educational conditions among the schools is problematic when seen from the viewpoint of equal educational opportunities.

The primary school and the high school courses will increase by one grade due to the educational system reform. Therefore, new classrooms will be needed. If students in the new grades increase at each school, it will require minimum a one-unit school building; and the current school buildings will need to increase by a maximum of 24.06%. Even if space is not provided for small student increases, and the increase in space is limited to the minimum requirement, it is still necessary to increase the current school buildings by 13.83%. Construction of new classrooms must be completed by 2028 when the reformed new educational system is completed. However, this seems to be difficult in terms of not only the cost, but also the construction period and the number of schools nationwide. Even if priorities are decided and steady construction is achieved, many schools will be forced to temporarily implement a new two-shift system. In contrast, this provides a good opportunity to think about the appropriate size of schools and efficient and effective regional school configuration plans given the large number of school buildings that need to be expanded.

1. Purpose

In order to improve the quality of school education, it is essential to provide appropriate facilities as well as the required number of teachers. Unfortunately, the condition of the school facilities is not well known. Due to the additional two grades under the educational system reform, the facilities need to be increased to accommodate the two additional grades, while the number of teachers is simultaneously increased. However, there is very limited published information concerning these issues. Therefore, after reviewing the current state of basic education facilities, future necessary measures are discussed.

2. Method

2.1 Data to be Used

Information about the facilities was included in the individual school data of 2017/18, and this information was analyzed in several ways. In addition, necessary simulations were conducted that considered the additional two grades under the educational system reform using this data.

The targets of the following analyses are the branch primary schools, the primary schools, the post primary schools, the branch middle schools, the middle schools, the branch high schools, and the high schools. The affiliate schools were not included. The size of the schools was indicated by the number of students. The number of students included not only students from KG to Grade 11, but also students who attended preschool courses. Although the number of students in preschool courses was small, classrooms were actually used. There were also schools with no students in the data, but it was impossible to distinguish whether they were closed, or the data was simply not available. Therefore, these schools were excluded in the calculation, and the maximum number of schools used in the following analyses was 46,138 schools. But, if there was a missing value, the school was excluded in the calculation each time.

2.2 Variables and Method of Analysis

In addition to general classrooms, special rooms used for administration such as the principal's offices and teachers' rooms, and special classrooms such as libraries, computer rooms, laboratories, LLs, media rooms, and gymnasiums were examined. These special rooms were examined to see if they existed or not, and their size when they existed. Regression analyses were conducted to know how the existence of the special rooms was explained by the year a school was established/upgraded, the rank of a school, and school type. Furthermore, the schools that seemed to be implementing a two-shift system were identified based on the correlation between the number of students, and the size of the school buildings. Capacity was also calculated based on the number of desks and chairs. In addition, various simulations were conducted on an increase in the area of school buildings required because of the educational system reform.

3. Result of the Analysis

3.1 Distribution of Schools by the Number of Students

Since the size of the facilities is largely determined by the number of students and the type of school, basic information on the number of students at each school was analyzed first. Figure 1 shows how many basic education schools existed for each size based on the number of students from preschool to grade 11. The size of most schools was small. When the total number of students at a school was divided into groups of 25 students, the maximum number of schools was shown to have 26-50 students, which was 17.66% of the total, and for schools with 51-75 students, it was 16.86% of the total. This was 53.02% of schools with up to 100 students. When schools with a larger number of

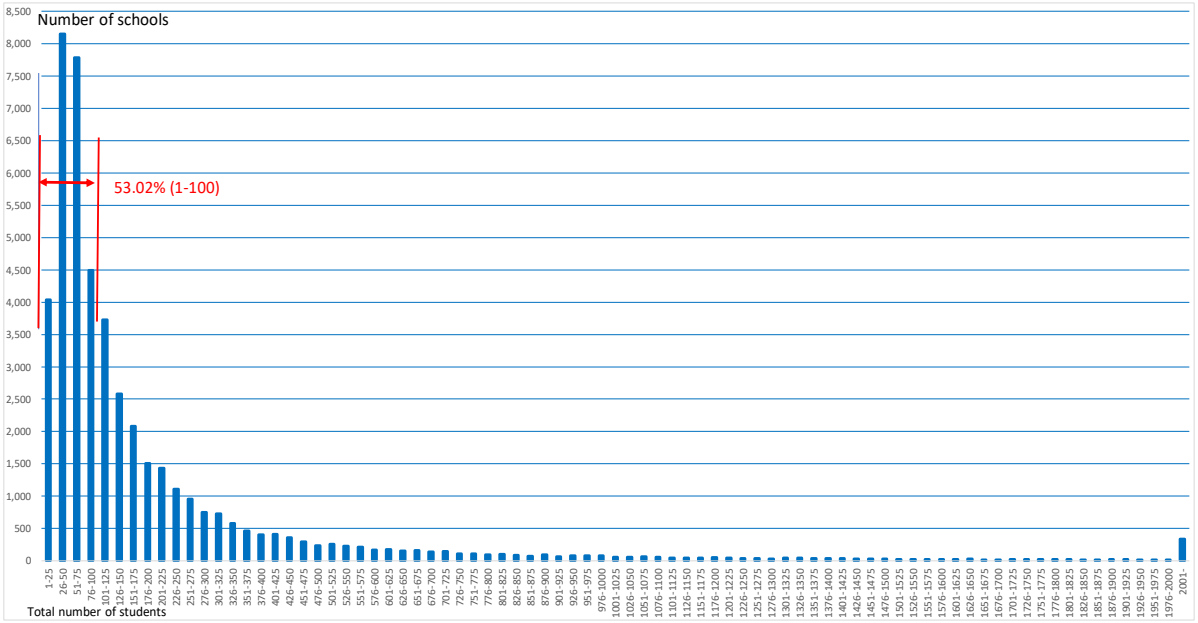

Figure 1 Distribution of Schools by the Number of Students

students were added, it was 61.10% for schools with up to 125 students, 71.19% for schools with up to 175 students, 82.03% for schools with up to 275 students, and 90.03% for schools with up to 450 students. As these ratios show, large schools appear to decrease drastically. Although there were schools with an extremely large number of students, their number was limited. It was 96.78% for schools with up to 1,000 students and 99.27% for schools with up to 2,000 students. The maximum number of students in one school was 6,668 and it was in the Yangon Region.

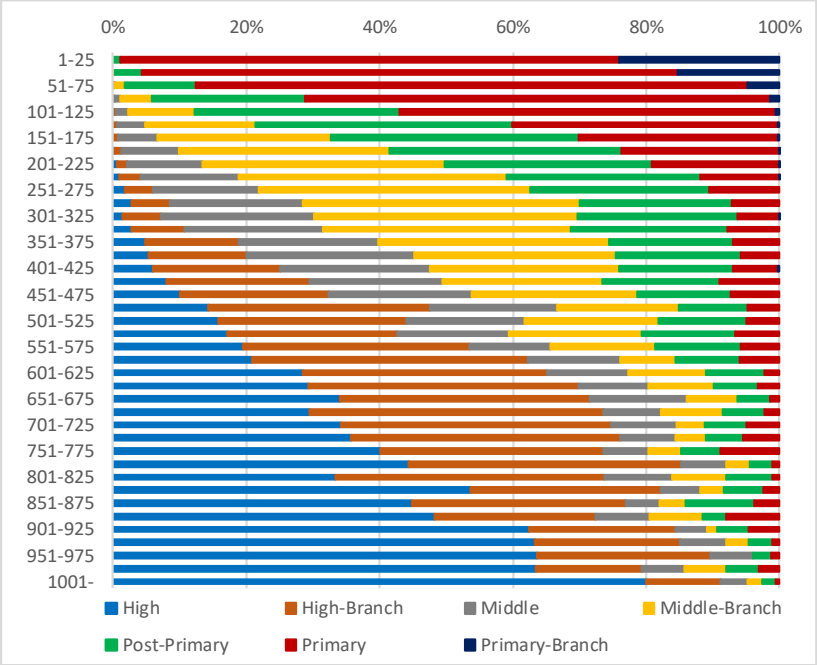

Figure 2 Ratio of School Type by the Number of Students

Figure 2 shows the distribution of various school types by the number of students. If the number of students was small, there was a tendency for a high ratio of lower schools; and the proportion of higher schools was high if the number of students was large. The branch primary schools accounted for 24.05% of schools with 1-25 students and it was the highest. It was only 15.25% for branch primary schools with 26-50 students. The proportion of branch primary schools sharply decreased among schools with a higher number of students. Primary schools with 51-75 students had the highest percentage of 82.20%. Among the student size groupings, the highest number of students at post primary schools was 126-150 students, or 38.55% of post primary schools. Primary schools with 126-150 students were still the largest at 39.76%, but post primary schools had the largest number with 151-175 students. As the number of students expanded, the proportion of branch middle schools gradually increased, and it was the largest at 41.53% with 276-300 students. The proportion for middle schools also gradually increased, but its largest ratio was 25.12% with 376-400 students. For this same number of students, the number of branch middle schools was the largest at 30.24%. For 476-500 students, the proportion of branch high schools was the largest at 33.33%. This proportion increased as the number of students increased, and it rose to 44.19% with 676-700 students. For 751-775 students, high schools had the largest ratio at 40.20%.

According to the cumulative distribution, 82.40% of branch primary schools were included when the number of students was 26-50 students or less, 66.77% of primary schools were included when the number of students was 51-75 students or less, 56.67% of post primary schools were included when the number of students was 126-150 students or less, 51.62% of branch middle schools were included when the number of students was 201-225 students or less, 50.52% of middle schools were included when the number of students was 276-300 students or less, 52.42% of branch high schools were included when the number of students was 551-575 students or less, and 48.33% of high schools were included when the number of students was 976-1,000 students or less. Thus, the relationship was clear between the type of school and school size as measured by the number of students.

Table 1 shows the calculation results based on the average number of students and the area of school buildings by school type. If one unit is 30ft x 30ft, the calculation was that one unit was used for two grades or more at branch primary schools and even primary schools (currently all schools have five grades). If there were special rooms other than ordinary classrooms, it

Table 1 Average Number of Students by School Type

School type	Average number of students	Average building area (ft^2)
High	1,218.0	28,303.0 (30 X 30 X 31.4)
High-branch	631.4	14,284.7 (30 X 30 X 15.9)
Middle	357.0	8,971.5 (30 X 30 X 10.0)
Middle-branch	255.5	6,329.6 (30 X 30 X 7.0)
Post-primary	175.5	4,211.5 (30 X 30 X 4.7)
Primary	75.8	2,941.2 (30 X 30 X 3.3)
Primary-branch	34.9	1,960.8 (30 X 30 X 2.2)

appeared that one unit was finally being used for one grade at middle schools (currently all schools have nine grades) and above.

Figure 3 shows the rank of schools by the number of students (categories A, B, C, D, E according to the distance from the Township Education Office). Generally, if the size of the school was small, the ratio for E and D increased, and if the size of the school was large, the ratio for A and B increased. There were schools of various sizes for each type of school. At the same time, there was also a correlation between the size and type of school as shown in Figure 2, and there were many higher type of schools in A and B.

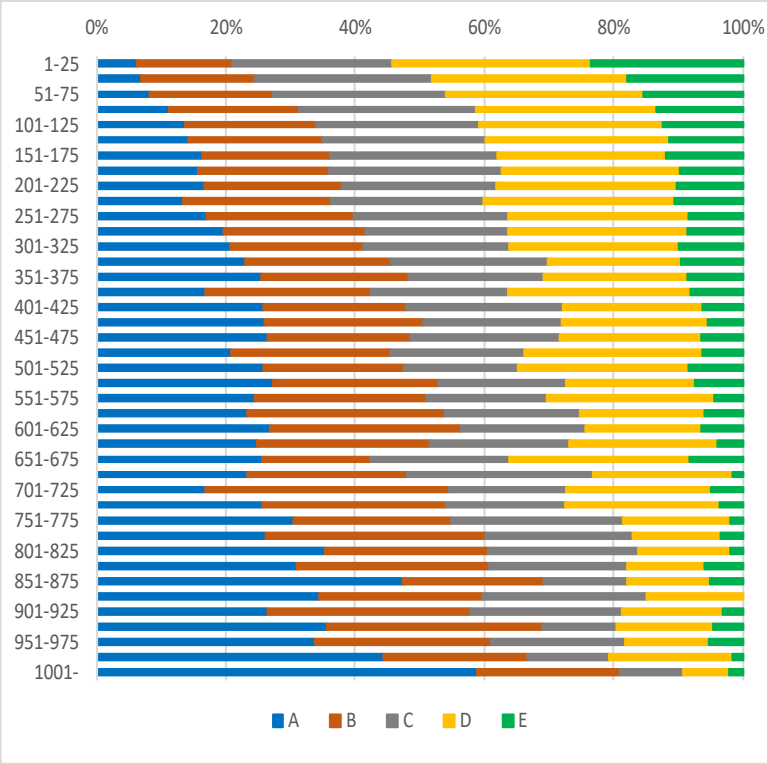

Figure 3 School Rank by the Number of Students

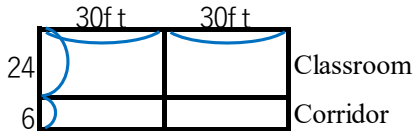

Figure 4 Basic Area of Minimum School Building (Two Units)

3.2 Area of School Buildings and Number of Students

Figure 4 shows the basic area of minimum school building common in Myanmar. The minimum area of a school building consists of two 30ft × 30ft units. When the school becomes larger in size, many 30 ft x 30 ft units can be connected. Since it includes the corridor, the area of one classroom is 24 ft x 30 ft=720 ft^2, and assumes that 45 students can be accommodated, which is equivalent to 16 ft^2 per student. When the corridor is included, it requires a slightly larger area of 20 ft^2 per student. However, even if the number of students is small, a 1,800 ft^2 school building may be necessary. If the number of students is small, one unit can be used for two or more classes. If there are no fixed walls between the units, the classes can be partitioned with a screen, and it is possible to cover all 5 primary school grades within two units. Table 1 also suggests such circumstances.

Figure 5 shows the area of all school buildings by the number of students. The linear relationship is clear between school size and the area of school buildings. When the number of students exceeded 1,000, the number of schools decreased to 3.2% of the total. There seemed to be a few large deviations between the trend line and the average size of the schools when the number of students was large, but the overall fitness was very high, and the coefficients were similar to the theoretical values.

The trend line was described as follows. The Formula-A shows that the lowest school building units was two units, and additional area was added according to the number of students.

Formula-A: Area of school buildings (ft^2)＝
18.18615 × Number of students + 1,791.152
(Adj.R^2=0.6988, Number of schools=45,576)

However, as clearly shown in Figure 5, the difference in average value from the trend value was large at schools with an extremely large number of students. Therefore, in order to clarify this point, Figure 6 shows the residual value obtained by subtracting the estimated trend value calculated by the regression equation from the actual value. As it is clear from Figure 6, the categories of school size where the average value of the school building area did not reach the trend value increased over 2,000 students. The tendency was stronger for larger schools. The reason for this must be a two-shift system. It is natural to consider introducing a two-shift system and effectively utilizing the school buildings, if

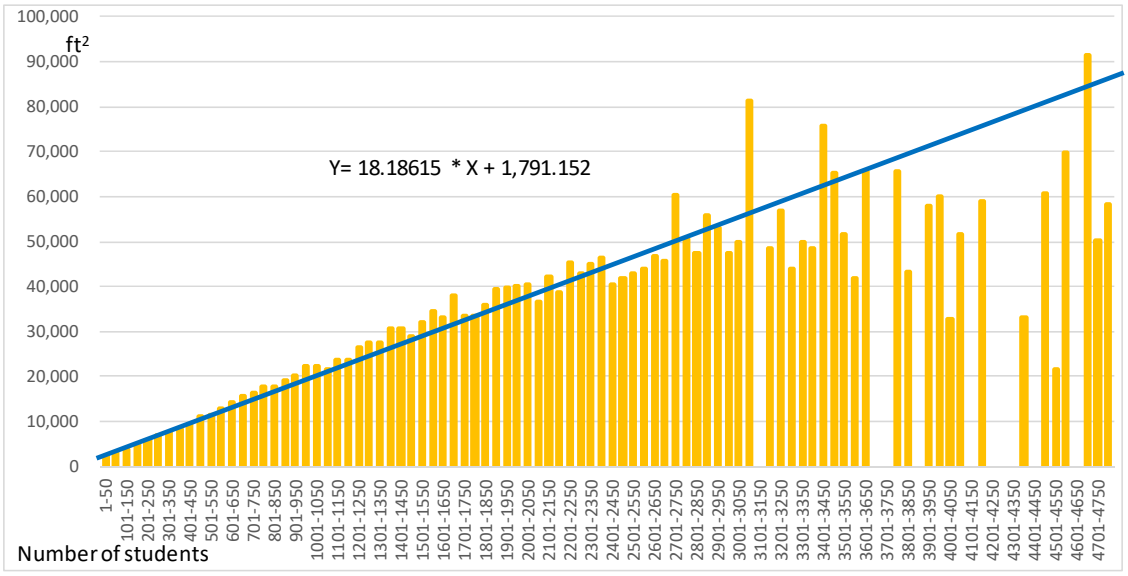

Figure 5 Area of School Buildings by the Number of Students

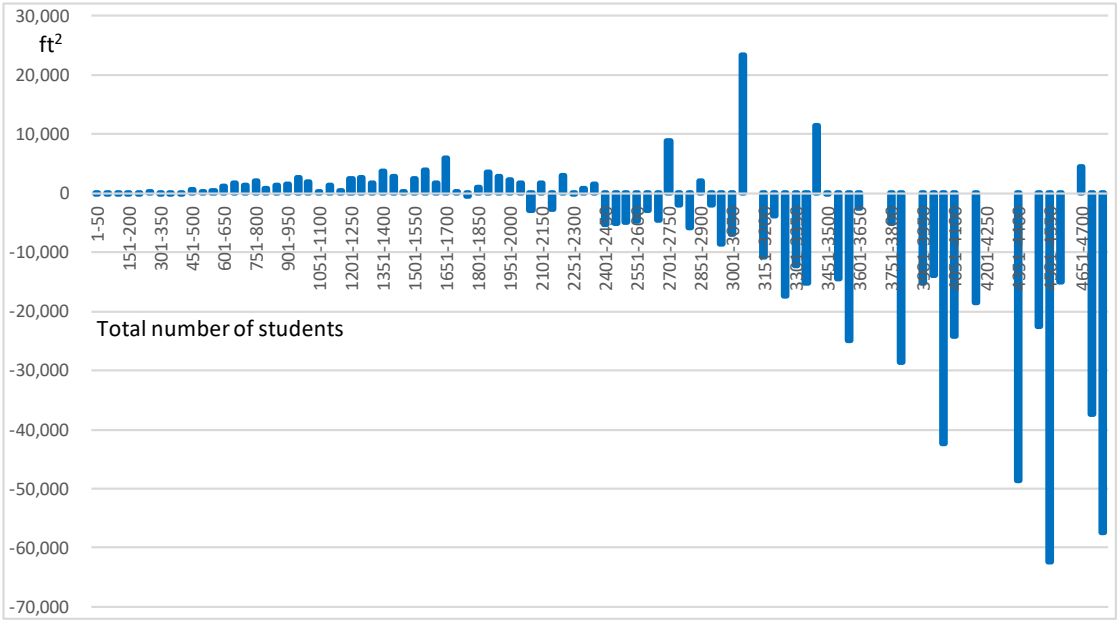

Figure 6 Residual from Trend of the Area of School Buildings by the Number of Students

the number of students exceeds a certain level and the school site is limited.

Figure 7 shows the area of school buildings per student by the number of students. For 1 -25 students, it showed a large value of 136.7 ft^2 per student, but it decreased with an increased number of students. For more than 1,000 students, it decreased to 20.3 ft^2 per student. It is close to the theoretical value for the standard area of school buildings, and it is surmised that one classroom is nearly full with students. As shown in Figure 1, 53.0% of schools had equal to or less than 100 students. For 76 - 100 students, an area of 40.8 ft^2 per student was required, which was twice as large as 20.3 ft^2 per student required for more than 1,000 students. Although this can be said to be spacious, it is inefficient, and a lot of resources are needed even if the facility side is considered. If schools like this can be reorganized for 176-200 students through merging and consolidation, only 28.9 ft^2 per student will be required, which is 71% of the space. This makes the usage of school buildings more efficient.

3.3 Number of Classes and Area of School Buildings

School education is usually conducted on a class basis. In Figure 4, the standard area of one classroom including the corridor is 900 ft^2. Figure 8 shows the value of the total area of school buildings divided by the number of classes that is the unit area of actual classes by school size. When the school size was extremely small with 1-25 students, the area was 389 ft^2. It was gradually increased to 900 ft^2 and even larger. If a classroom is used for several small classes, the area of school buildings per class is smaller. In contrast, if the principal's office, teachers' room, laboratory, library, etc. are included in the school buildings, the school building area per class increases by calculation. Since the standard area of the school buildings including the corridor is 900 ft^2, the distribution as shown in Figure 8 is fully convincing.

Figure 8 also shows a line graph excluding special rooms. When considering the size of the special rooms, the calculation included the corridor based on Figure 4, thus the value of the bar in Figure 8 also included the corridor. As mentioned in the next section, special rooms were more common in large-scale schools, thus the value of the line differs greatly from the value of the bar in large-scale schools. When the school size increased, the area of school buildings per class asymptotically approached 900 ft^2.

Figure 8 also shows the number of students per class. If the size of the school was small, the number of students per class was also small, but if the school size became larger and exceeded 500 students, the average number of students per class exceeded 40; and when the number of students exceeded 1,000, the number of students per class exceeded 50. Although more than half of the schools had 100 students or less, the imbalance among the schools was extremely large in view of the fact that the average was 14.9 students per class for 75-100 students.

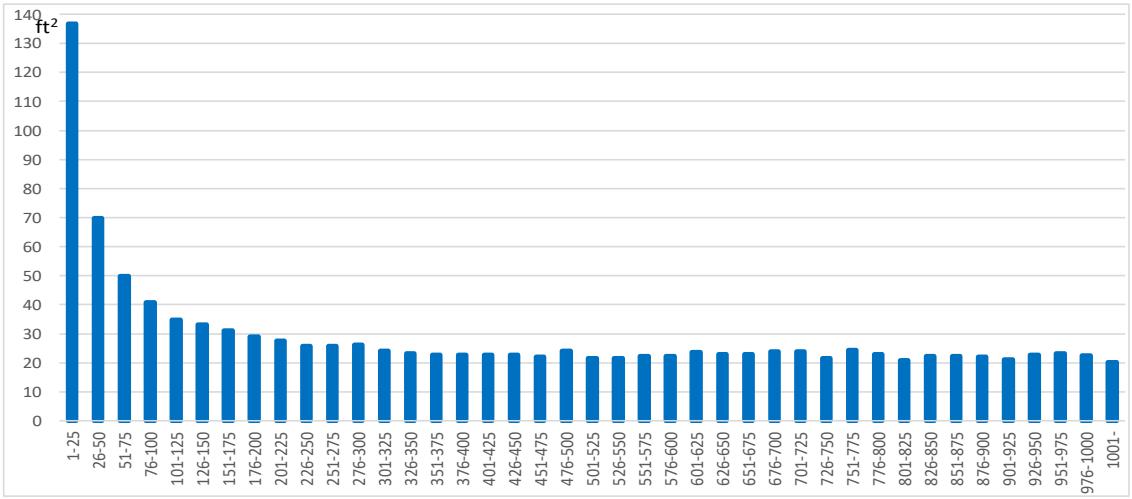

Figure 7 Area of School Buildings per Student by the Number of Students

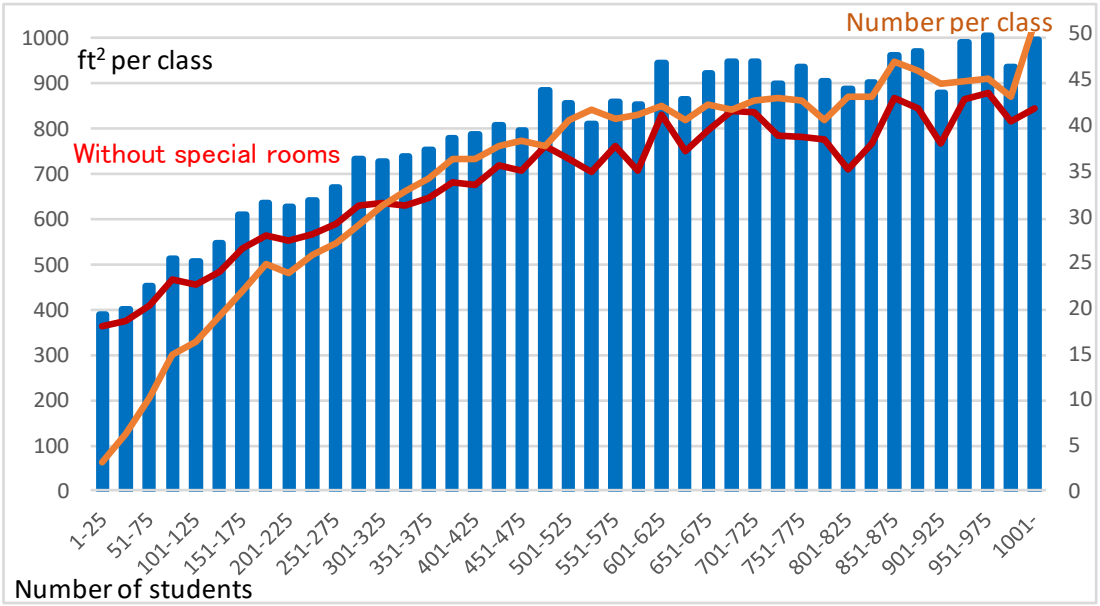

Figure 8 Area of School Buildings per Class (Classified by the Existence of Special Rooms)

Instead of preparing school districts according to the population and maintaining appropriately sized schools with 2 to 3 classes for each grade, many small schools were gradually created within small communities; and the more popular schools among them developed into large schools over time. This appears to be the historical result of the school development process in Myanmar.

3.4 Special Rooms

Table 2 shows the existence ratio of special rooms by school type and another category. In addition, the ratio of schools with no special rooms, excluding the principal's office and teachers' room, where such rooms were expected to improve the quality of education, was also recorded. The principal's office, the teachers' room, the library and other special rooms are essentially necessary for any type of school, but the laboratory, the computer room, and LL etc. are generally not used unless the school has a high school course. If the size of the school was not large to some extent, these special rooms were not affordable. Even the basic special rooms such as the principal's office, teachers' room, and library were not found at all schools. In processing the data, if information concerning special rooms was not recorded, the school was treated as having no such rooms. In reality, there may have been a special room, but the size was unknown. Therefore, it is necessary to note that the information on special rooms may be somewhat underestimated. As Table 2 shows, since the existence ratio of special rooms was relatively low, the analysis was focused on the existence ratio of special rooms at each school and their size when it existed, but not the average area.

In general, the existence ratio of special rooms included here was in the order of the principal's office, library, teachers' room, computer room, laboratory, LL, media room, and gymnasium. In addition, for school type, the ratio was high for high schools and branch high schools, and low for the lower schools such as the branch primary schools and primary schools. When seen in terms of school rank, the ratio was high for schools near TEO (Township Education Office) such as category A schools, and low for distantly located schools in category E. Within the urban/rural classification, the ratio was high in urban areas and low in rural areas. When seen from the standpoint of the year a school was established/upgraded, there was a tendency for the existence ratio to be higher if the school was older and established, but this was not necessarily clear in Table 2. Detailed analyses were conducted according to the individual special rooms shown below.

3.4.1 Office for School Principal

As is clear from Table 2, a principal's office was the most popular among the special rooms. If the

number of students exceeded 750, more than 90% of the schools had principal's offices, but even for schools with 1-25 students, 26.1% had principal's offices. Schools maintain important documents such as the school registry, and a room for administrative affairs is necessary. In a small school, the principal's office also fulfills the role of administrative office. Since the size of a standard room is 30 ft x 24 ft = 720 ft^2, as shown in Figure 4, this value was rarely exceeded even in large schools as shown in Figure 9. In contrast, about half this size was used as a principal's office in a small school.

Table 3 examines the extent to which the principal's office was justified based on the year a school was established/upgraded, the rank of a school and the school type. Since the value for the presence or absence of a principal's office is binary, 1 or 0, this was the result of logistic regression analysis that converted the value into logit. All explanatory variables were dummy variables[1].

The logit was explained clearly by the school type, the rank of a school, the year a school was established/upgraded, and such a school had a high probability of having a principal's office if the school provided higher basic education, was close to TEO, and well established. For example, compared to the branch primary school, the coefficient for high schools was larger by 4.0424 logit. The probability p was calculated as 0.9827 from the formula,

Table 2 Existence Ratio of Special Rooms by Category

School type	Principal room	Teacher room	Library	Computer room	Laboratry	LL	Media room	Sport hall	Non (All)	Non (Educa.)
High	0.929	0.550	0.660	0.538	0.488	0.367	0.320	0.047	0.028	0.167
High-branch	0.879	0.403	0.483	0.160	0.109	0.037	0.033	0.006	0.079	0.451
Middle	0.782	0.271	0.308	0.058	0.020	0.008	0.019	0.007	0.181	0.676
Middle-branch	0.557	0.116	0.184	0.005	0.002	0.001	0.002	0.003	0.367	0.811
Post-primary	0.429	0.067	0.104	0.003	0.000	0.001	0.001	0.002	0.523	0.893
Primary	0.355	0.041	0.080	0.003	0.000	0.000	0.001	0.001	0.606	0.917
Primary-branch	0.119	0.015	0.024	0.000	0.000	0.000	0.000	0.000	0.857	0.976
School rank										
A	0.672	0.214	0.332	0.149	0.116	0.092	0.088	0.019	0.284	0.633
B	0.512	0.115	0.173	0.041	0.030	0.021	0.018	0.002	0.438	0.809
C	0.409	0.085	0.118	0.018	0.014	0.008	0.007	0.003	0.549	0.872
D	0.363	0.066	0.098	0.012	0.011	0.003	0.002	0.001	0.593	0.894
E	0.336	0.069	0.071	0.006	0.006	0.003	0.002	0.001	0.625	0.923
U/R										
Urban	0.752	0.269	0.404	0.197	0.150	0.123	0.115	0.026	0.209	0.551
Rural	0.407	0.082	0.116	0.019	0.015	0.008	0.007	0.002	0.548	0.873
Year established/upgraded										
1980	0.450	0.092	0.148	0.062	0.054	0.041	0.042	0.010	0.223	0.839
1990	0.384	0.058	0.103	0.019	0.017	0.012	0.011	0.003	0.199	0.890
2000	0.403	0.092	0.141	0.040	0.035	0.025	0.019	0.002	0.084	0.841
2010	0.541	0.124	0.173	0.045	0.031	0.021	0.016	0.004	0.070	0.808
2011	0.542	0.149	0.163	0.052	0.042	0.035	0.027	0.003	0.011	0.809
2012	0.476	0.153	0.220	0.083	0.056	0.046	0.032	0.003	0.018	0.745
2013	0.426	0.119	0.173	0.051	0.032	0.020	0.017	0.001	0.072	0.803
2014	0.485	0.141	0.187	0.040	0.025	0.016	0.014	0.004	0.069	0.794
2015	0.394	0.092	0.127	0.019	0.016	0.005	0.004	0.001	0.127	0.861
2016	0.467	0.103	0.140	0.018	0.010	0.005	0.004	0.001	0.056	0.853
2017	0.499	0.150	0.170	0.017	0.008	0.003	0.004	0.003	0.074	0.819

Note: Less than 1 % was marked.

[1] It is meaningless to compare magnitudes of relationship between regression coefficients of categories beyond items since regression coefficients of dummy variables are obtained by setting a coefficient of one category to 0 a priori in advance for each item. The comparison between items is performed by the width (range) of the regression coefficients within each item.

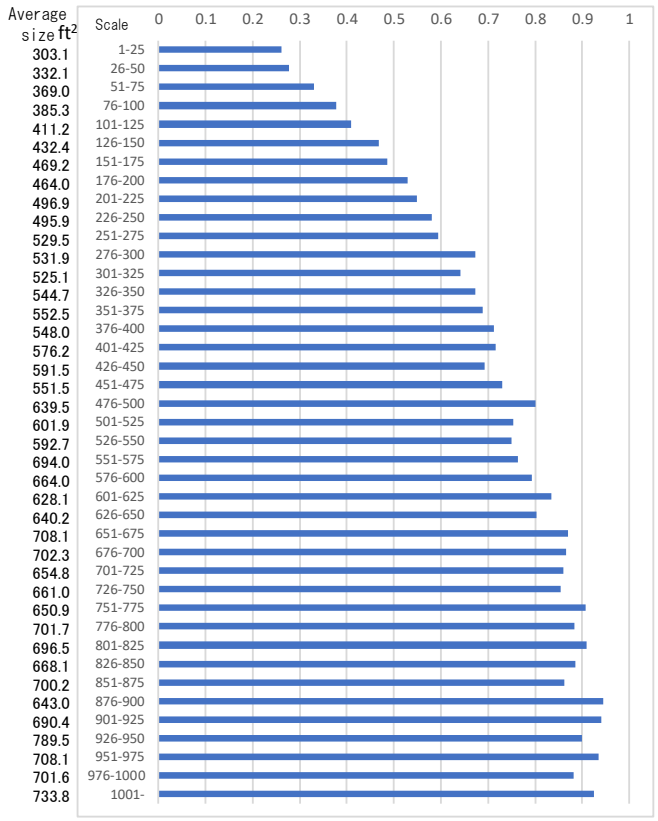

Figure 9 Area of a Principal's office and Its Existence Ratio by the Number of Students

Table 3 Explanation for the Existence of a Principal's office

Item	Category	Coef.	z	P>z	Range
Year established/ upgraded	1980	0.5184	9.77	0.000	0.7274
	1990	0.4311	8.02	0.000	
	2000	0.3103	5.21	0.000	
	2010	0.4136	7.56	0.000	
	2011	0.3985	3.89	0.000	
	2012	0.0527	0.57	0.570	
	2013	0.0058	0.10	0.922	
	2014	-0.0245	-0.43	0.667	
	2015	-0.2090	-4.03	0.000	
	2016	0.1317	2.18	0.029	
	2017	0.0000	-	-	
School rank	A	0.9534	22.81	0.000	1.0802
	B	0.4007	10.76	0.000	
	C	0.0611	1.71	0.087	
	D	-0.1268	-3.59	0.000	
	E	0.0000	-	-	
School type	High	4.0424	39.68	0.000	4.0424
	High-branch	3.7542	39.40	0.000	
	Middle	3.0964	38.21	0.000	
	Middle-branch	2.0985	31.99	0.000	
	Post-primary	1.4757	22.95	0.000	
	Primary	0.8452	12.76	0.000	
	Primary-branch	0.0000	-	-	
Constant		-2.0429	-28.57	0.000	
			Number of obs =		46,424
			Pseudo R^2 =		0.1431

Logit (p) = ln (p / (1 - p)),

and it showed that the probability of a principal's office in a high school was higher than in a branch primary school by 0.9827.

3.4.2 Teachers' Room

As shown in Figure 10, the existence ratio of a teachers' room was relatively small compared to the principal's office. However, there is no reason to believe that teachers had no place to stay in a school; and they may have had their desks and chairs in the classrooms or in various special rooms. The existence ratio was about 10% for schools with 200 students, and only about 50% for schools with 1,000 students. When there was a teacher's room, the size of the room was almost the same as the principal's office. A large school, usually a middle school or above, may have special rooms related to the subjects taught; and even if the number of teachers increased, it appears that teachers' rooms were not enlarged very much.

Using the logistic regression analysis, Table 4 shows the extent to which the existence of a teachers' room can be explained by the year a school was established/upgraded, the rank of a school, and the school type. Again, it can be said there was a higher probability of a school having a teachers' room if the school provided higher basic education, was close to TEO, and well established.

3.4.3 Library

As shown in Figure 11, the existence ratio of a library was also not very high. When the number of students was 126-150, the ratio was over 10%. It was more than 30% if the number of students was 401-425. The area of the library was about half a unit to one unit. Table 5 shows the extent to which the existence of a library was explained by the year a school was established/ upgraded, the rank of a school, and the school type through logistic regression analysis. Again, it can be said that a school had a higher probability of having a library if the school provided higher basic education, was close to TEO, and well established. The difference was greater depending on the rank of a school rather than a principal's office or a teachers' room. The

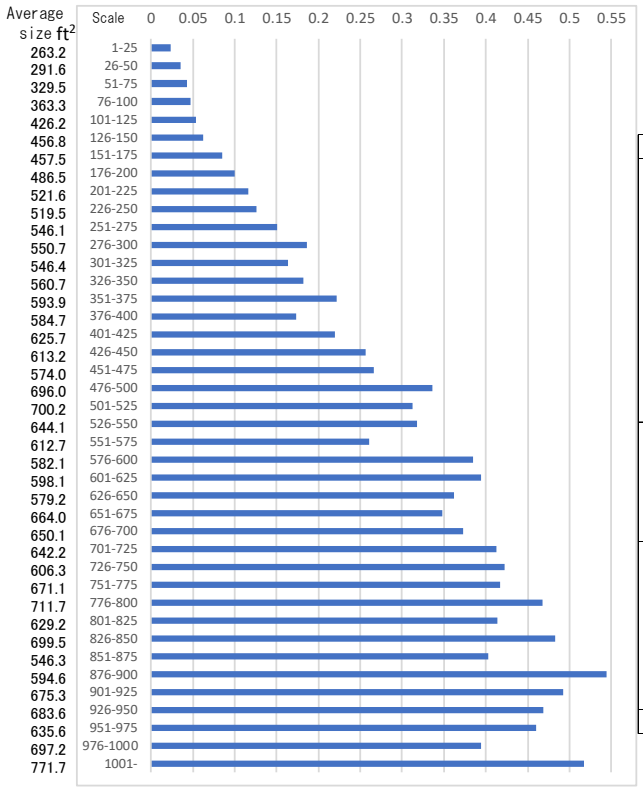

Table 4 Explanation for the Existence of a Teachers' Room

Item	Category	Coef.	z	P>z	Range
Year established/ upgraded	1980	0.3271	4.18	0.000	0.5326
	1990	0.2507	2.95	0.003	
	2000	0.3086	3.42	0.001	
	2010	0.0847	1.09	0.275	
	2011	0.1014	0.71	0.478	
	2012	-0.0377	-0.31	0.760	
	2013	-0.0452	-0.54	0.592	
	2014	-0.1031	-1.35	0.177	
	2015	-0.2055	-2.71	0.007	
	2016	-0.1661	-1.84	0.065	
	2017	0.0000	-	-	
School rank	A	0.5842	8.71	0.000	0.9212
	B	0.0929	1.43	0.154	
	C	-0.0491	-0.76	0.446	
	D	-0.3370	-5.16	0.000	
	E	0.0000	-	-	
School type	High	3.9238	23.86	0.000	3.9238
	High-branch	3.6374	22.06	0.000	
	Middle	2.9903	18.04	0.000	
	Middle-branch	2.0765	12.77	0.000	
	Post-primary	1.3946	8.51	0.000	
	Primary	0.5899	3.56	0.000	
	Primary-branch	0.0000	-	-	
Constant		-4.0200	-24.16	0.000	
			Number of obs =		46,424
			Pseudo R^2 =		0.2148

Figure 10 Area of a Teachers' Room and Its Existence Ratio by the Number of Students

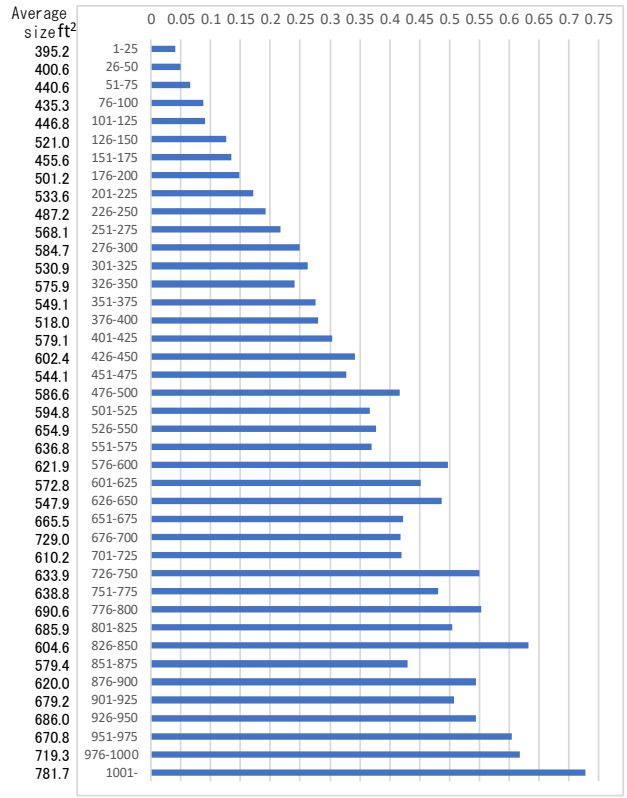

Table 5 Explanation for the Existence of a Library

Item	Category	Coef.	z	P>z	Range
Year established/ upgraded	1980	0.5450	7.61	0.000	0.6865
	1990	0.5025	6.68	0.000	
	2000	0.5049	6.27	0.000	
	2010	0.1926	2.71	0.007	
	2011	-0.1251	-0.91	0.363	
	2012	0.2235	1.99	0.046	
	2013	0.1243	1.63	0.104	
	2014	-0.0080	-0.11	0.910	
	2015	-0.1415	-2.03	0.042	
	2016	-0.1019	-1.24	0.214	
	2017	0.0000	-	-	
School rank	A	1.3515	21.95	0.000	1.3515
	B	0.6304	10.45	0.000	
	C	0.3299	5.47	0.000	
	D	0.1163	1.92	0.055	
	E	0.0000	-	-	
School type	High	3.6304	27.20	0.000	3.6304
	High-branch	3.2809	24.56	0.000	
	Middle	2.5247	18.77	0.000	
	Middle-branch	1.9780	15.32	0.000	
	Post-primary	1.1934	9.16	0.000	
	Primary	0.4938	3.73	0.000	
	Primary-branch	0.0000	-	-	
Constant		-3.9092	-28.60	0.000	
			Number of obs =		46,424
			Pseudo R^2 =		0.1955

Figure 11 Area of a Library and Its Existence Ratio by the Number of Students

existence of library is directly related to the learning environment of children. The importance of the library has been pointed out by the current administration. Of course, it is meaningless unless it is used effectively, but the existence of a library and maintenance of useful books should be first made available to students. Although it is possible to arrange bookshelves in classrooms or in the corridors, management of the books will eventually become a problem.

3.4.4 Computer Room

Computer rooms existed at 53.8% of the high schools and 16.0% at branch high schools; and the distribution of their existence ratio by school size is shown in Figure 12. The area of a computer room was about one unit. However, there were computer rooms at middle schools or lower schools even though the number was limited. Therefore, as shown in Table 6, when the logistic regression analysis was conducted to see the variables explaining the existence of a computer room, naturally, the explanatory power of the school type was greatly prominent. However, the effect of the year a school was established/upgrades and the rank of a school was also significant; and a difference in facilities between schools was seen.

Computer education is very important for life in the future; and the fact that the existence ratio differed greatly among schools is problematic from the standpoint of equal educational opportunity for all, despite the fact there is a limiting external condition that computers cannot be used without electric power.

3.4.5 Laboratory

As there are laboratories generally only at high school courses, there are no laboratories in small schools except for a few exceptions. However, as shown in Figure 13, it was over 50% even at schools with more than 1,000 students. There are only a limited number of middle schools or lower type of schools with a student body exceeding 1,000. A condition where only half of the schools of this size has laboratories is problematic in view of the educational outcome. Priority was placed on classrooms and schools cannot afford to have a

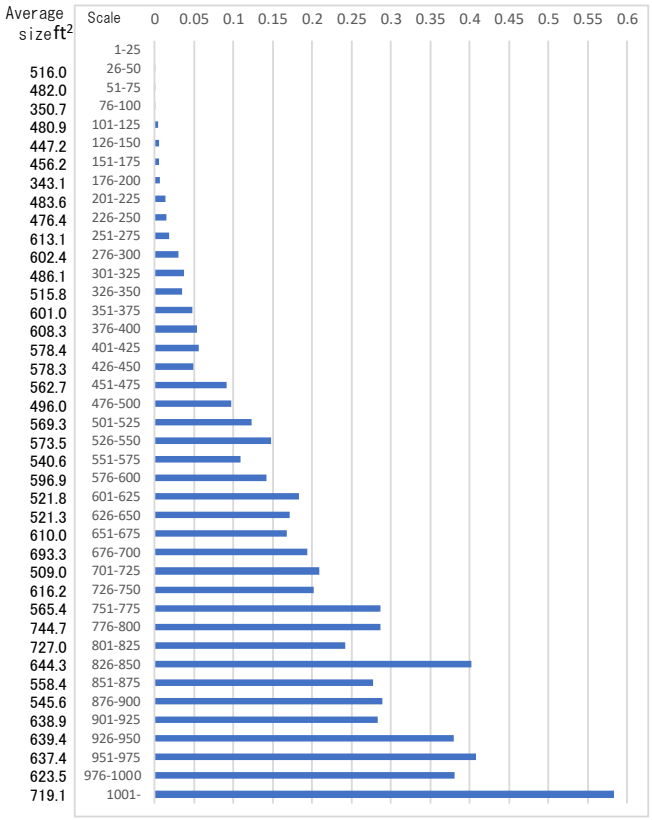

Figure 12 Area of a Computer Room and Its Existence Ratio by the Number of Students

Table 6 Explanation for the Existence of a Computer Room

Item	Category	Coef.	z	P>z	Range
Year established/ upgraded	1980	2.6748	16.03	0.000	2.6748
	1990	2.0064	10.61	0.000	
	2000	1.7016	9.17	0.000	
	2010	1.5031	8.83	0.000	
	2011	0.8706	3.29	0.001	
	2012	1.1885	5.67	0.000	
	2013	1.2013	6.92	0.000	
	2014	0.7272	4.24	0.000	
	2015	0.6890	3.76	0.000	
	2016	0.4327	1.98	0.047	
	2017	0.0000	-	-	
School rank	A	1.9462	10.41	0.000	1.9462
	B	0.9905	5.26	0.000	
	C	0.5523	2.84	0.004	
	D	0.2219	1.12	0.261	
	E	0.0000	-	-	
School type	High	0.0000	-	-	6.6526
	High-branch	-1.1660	-12.82	0.000	
	Middle	-2.5164	-21.64	0.000	
	Middle-branch	-4.5995	-22.76	0.000	
	Post-primary	-5.6241	-24.86	0.000	
	Primary	-6.6526	-46.16	0.000	
	Primary-branch	-	-	-	
Constant		-2.3947	-10.93	0.000	
			Number of obs =		43,601
			Pseudo R^2 =		0.5931

laboratory. The size of the laboratory greatly exceeded the standard size for one unit or 720 ft^2. It indicated that there may be two or more different kind of laboratories in the school.

Table 7 shows variables that explain the presence or absence of a laboratory. As in the case for computer rooms, the existence of a laboratory depended on the school type, the year a school was established/upgraded, and the rank of a school. Out of 46,444 schools included in the original data, 900 schools had both computer rooms and laboratories. In contrast, there were 849 schools that had computer rooms but no laboratory, and 459 schools that had laboratories but no computer room. Given the fact that computer education is a recent trend, having a computer room appears to be more advantageous than a laboratory in view of the limited resources of school buildings.

3.4.6 Language Lab (LL)

A language lab is necessary in language learning. There was a LL at about 36.7% of high schools and 3.7% of branch high schools. The lower schools also had a LL, although they were exceptions. As shown in Figure 14, the existence ratio did not reach 10% until the schools had 726-750 students. It was 40% even for schools with more than 1,000 students. As shown in Table 8, LLs were most commonly seen based on the school type, followed by the year a school was established/upgraded, and the rank of a school as in the case of laboratories, computer rooms, and other special rooms.

3.4.7 Media Room

Based on school category, a media room was located at 32.0% of high schools and 3.3% of branch high schools; and the rate was lower than a LL. It was 1.9% for middle schools, which was slightly higher than the existence of a LL. Nevertheless, as shown in Figure 15, it was 35% even for schools with more than 1,000 students; and it seemed that the priority for a media room was not high compared to other special rooms. As shown in Table 9, the contribution of each variable explaining the presence of a media room was very similar to a LL.

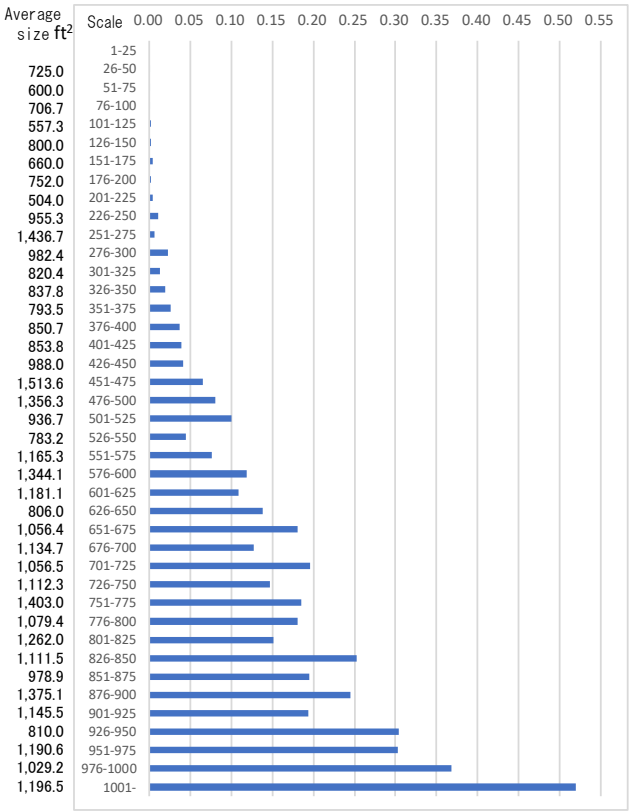

Figure 13 Area of a Laboratory and Its Existence Ratio by the Number of Students

Table 7 Explanation for the Existence of a Laboratory

Item	Category	Coef.	z	P>z	Range
Year established/ upgraded	1980	3.4313	15.71	0.000	3.4313
	1990	2.8158	11.63	0.000	
	2000	2.2499	9.80	0.000	
	2010	1.7311	7.87	0.000	
	2011	1.2897	4.23	0.000	
	2012	1.2838	4.99	0.000	
	2013	1.2969	5.78	0.000	
	2014	0.8807	3.91	0.000	
	2015	1.3227	5.75	0.000	
	2016	0.5190	1.80	0.072	
	2017	0.0000	-	-	
School rank	A	1.1669	5.60	0.000	1.1669
	B	0.4405	2.09	0.036	
	C	0.2719	1.25	0.211	
	D	0.0891	0.41	0.684	
	E	0.0000	-	-	
School type	High	0.0000	-	-	9.8259
	High-branch	-1.2575	-12.43	0.000	
	Middle	-3.5291	-20.37	0.000	
	Middle-branch	-5.4179	-15.94	0.000	
	Post-primary	-8.4816	-8.47	0.000	
	Primary	-9.8259	-16.84	0.000	
	Primary-branch	-	-	-	
Constant		-2.5853	-9.80	0.000	
			Number of obs =		43,601
			Pseudo R^2 =		0.6695

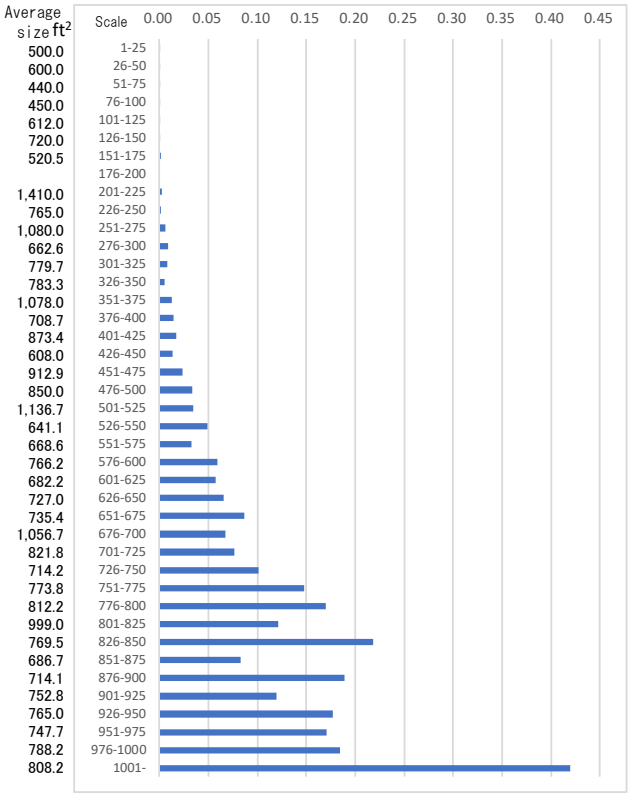

Figure 14 Area of a LL and Its Existence Ratio by the Number of Students

Table 8 Explanation for the Existence of a LL

Item	Category	Coef.	z	P>z	Range
Year established/ upgraded	1980	3.0558	9.78	0.000	3.0558
	1990	2.6609	8.02	0.000	
	2000	2.5380	7.69	0.000	
	2010	2.1908	6.71	0.000	
	2011	2.0278	5.10	0.000	
	2012	1.9596	5.54	0.000	
	2013	1.6849	5.08	0.000	
	2014	1.4183	4.26	0.000	
	2015	1.0442	2.89	0.004	
	2016	0.9298	2.23	0.026	
	2017	0.0000	-	-	
School rank	A	1.5648	5.95	0.000	2.0189
	B	0.7899	2.96	0.003	
	C	0.3270	1.17	0.241	
	D	-0.4541	-1.52	0.128	
	E	0.0000	-	-	
School type	High	0.0000	-	-	7.6316
	High-branch	-1.9152	-13.03	0.000	
	Middle	-3.6419	-14.72	0.000	
	Middle-branch	-5.5548	-10.99	0.000	
	Post-primary	-6.3104	-12.51	0.000	
	Primary	-7.6316	-22.39	0.000	
	Primary-branch	-	-	-	
Constant		-3.6184	-9.50	0.000	
			Number of obs =		43,601
			Pseudo R^2 =		0.6378

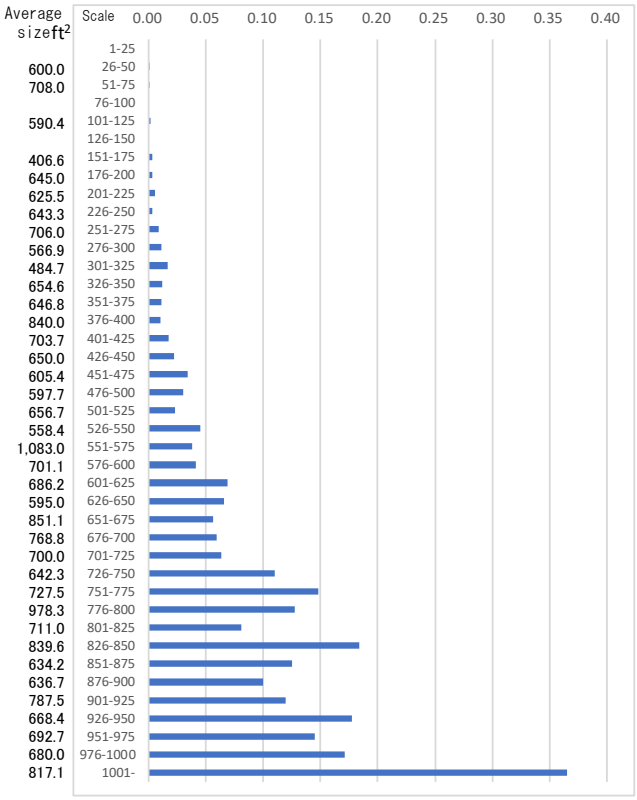

Figure 15 Area of a Media Room and Its Existence Ratio by the Number of Students

Table 9 Explanation for the Existence of a Media Room

Item	Category	Coef.	z	P>z	Range
Year established/ upgraded	1980	3.0241	10.42	0.000	3.0241
	1990	2.4068	7.73	0.000	
	2000	2.0612	6.58	0.000	
	2010	1.7432	5.61	0.000	
	2011	1.6087	4.04	0.000	
	2012	1.4522	4.15	0.000	
	2013	1.3840	4.38	0.000	
	2014	1.0962	3.46	0.001	
	2015	0.6209	1.75	0.080	
	2016	0.5796	1.40	0.162	
	2017	0.0000	-	-	
School rank	A	1.8798	6.01	0.000	2.1938
	B	1.1050	3.48	0.000	
	C	0.7202	2.20	0.028	
	D	-0.3140	-0.88	0.378	
	E	0.0000	-	-	
School type	High	0.0000	-	-	7.0852
	High-branch	-1.6403	-10.50	0.000	
	Middle	-2.5199	-14.49	0.000	
	Middle-branch	-4.4492	-12.28	0.000	
	Post-primary	-5.2460	-14.55	0.000	
	Primary	-7.0852	-24.71	0.000	
	Primary-branch	-	-	-	
Constant		-3.9620	-9.89	0.000	
			Number of obs =		43,601
			Pseudo R^2 =		0.6033

3.4.8 Gymnasium

It can be said that there were hardly any gymnasiums; and the existence ratio was 4.7% even at high schools. As shown in Figure 16, it did not reach 6% even at schools with more than 1,000 students. The size of the gymnasiums varied, but there were a few scattered schools with large gymnasiums equivalent to an area of three units. Unlike the laboratory, LL, or media room, the gymnasium is unrelated to the curriculum of a specific school level. As shown in Table 10, the school type did not fully explain the existence of a gymnasium compared to other special rooms. However, there were differences based on the year a school was established/upgraded, and the rank of a school as in the case of other special rooms.

3.4.9 Existence of Special Rooms

The problem with special rooms is that classrooms are given priority in school buildings. Since the size of the school buildings as a whole is inadequate, there is not enough space to create special rooms even with an increased number of students. There may have been special rooms at the time a school was established, but as the number of students increased, these special rooms may have been converted to regular classrooms. Figures 5 and 6 show the possibility that many two-shift schools were seen not only among large schools with more than 2,000 students, but also for small schools as well.

In contrast, if a school adopted a two-shift system, there may have been some margin to create special rooms. Figures 9 to 16 show the size of schools with up to 1,000 students. Therefore, Figure 17 showed the ratio of special rooms at very large middle schools and above. The number of schools in the category of large schools was small and the line showing the average was not stable, but with the exception of the gymnasium, it was shown that the existence ratio of various special rooms came close to 100%. It seemed that many large schools had adopted a two-shift system. Although the two-shift system has a negative image, discretion concerning the use of school buildings increases, and there is also the merit of making it easier to create special rooms.

Table 11 shows the average existence ratio of each special room when the area of school buildings was

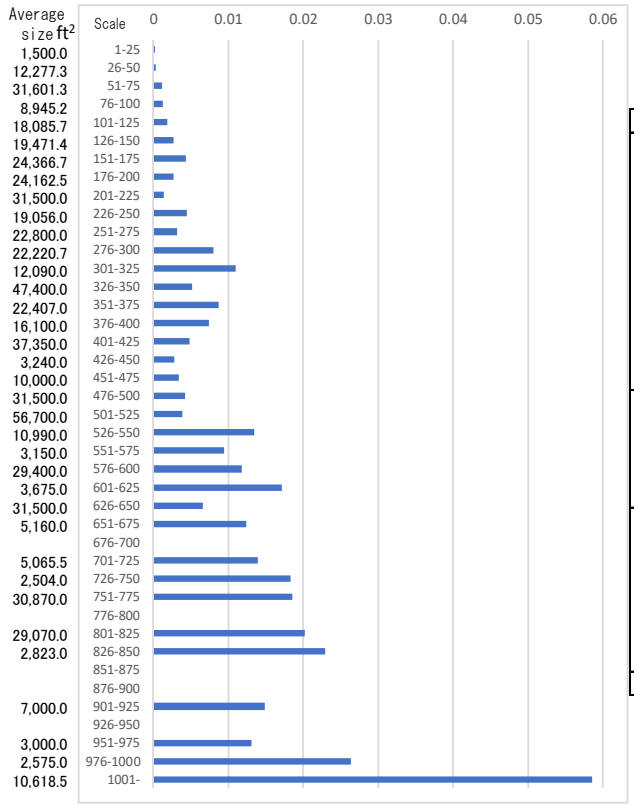

Figure 16 Area of a Gymnasium and Its Existence Ratio by the Number of Students

Table 10 Explanation for the Existence of a Gymnasium

Item	Category	Coef.	z	P>z	Range
Year established/ upgraded	1980	1.6881	4.55	0.000	2.5218
	1990	1.0825	2.59	0.010	
	2000	0.4511	0.94	0.348	
	2010	0.4841	1.14	0.256	
	2011	0.0525	0.07	0.947	
	2012	-0.0521	-0.08	0.938	
	2013	-0.8337	-1.38	0.169	
	2014	0.2763	0.65	0.513	
	2015	-0.4602	-0.94	0.350	
	2016	-0.5599	-0.92	0.359	
	2017	0.0000	-	-	
School rank	A	1.1773	3.18	0.001	1.7560
	B	-0.5788	-1.33	0.183	
	C	0.3937	1.04	0.298	
	D	-0.4211	-1.00	0.315	
	E	0.0000	-	-	
School type	High	0.0000	-	-	3.4164
	High-branch	-0.6620	-1.86	0.063	
	Middle	-1.0954	-3.83	0.000	
	Middle-branch	-1.1358	-3.70	0.000	
	Post-primary	-2.2623	-6.78	0.000	
	Primary	-3.4164	-15.73	0.000	
	Primary-branch	-3.1082	-3.02	0.003	
Constant		-4.6252	-9.90	0.000	
			Number of obs =		46,424
			Pseudo R^2 =		0.2499

Figure 17 Existence Ratio of Special Rooms (Middle School and Above)

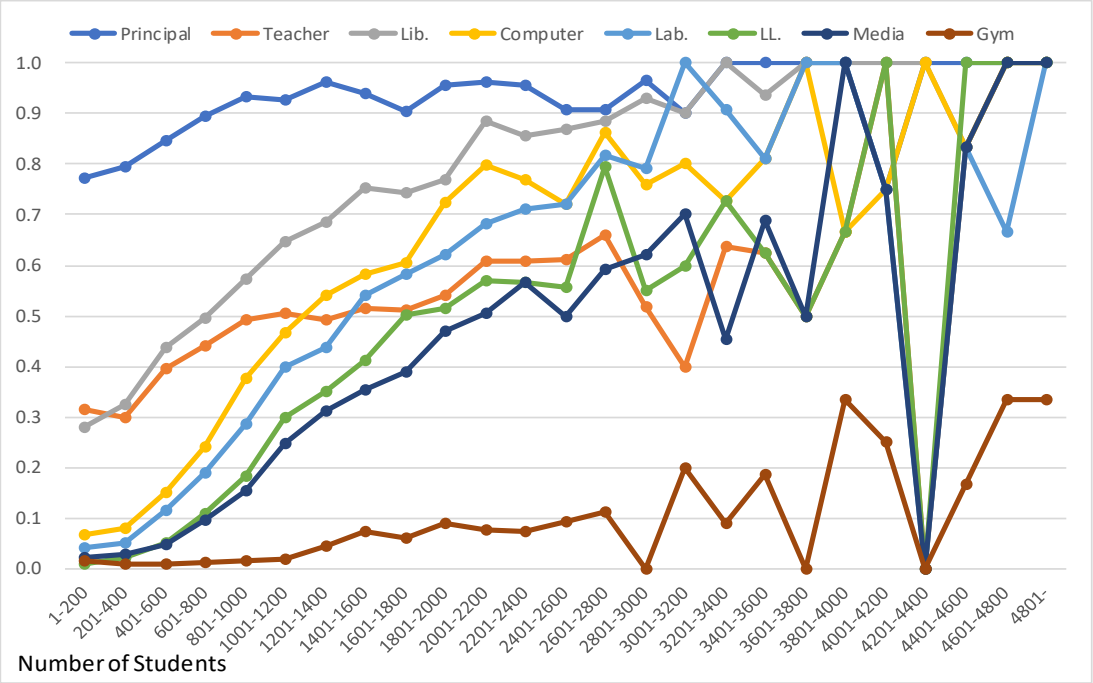

Table 11 Existence Ratio of Special Rooms According to Sufficient Area of School Buildings

Special room	More than estimated	Less than estimated
Principal room	0.6104	0.3664
Teacher room	0.1818	0.0629
Library	0.2515	0.0959
Laboratory	0.0643	0.0121
Media room	0.0406	0.0075
Computer room	0.0812	0.0163
LL	0.0432	0.0088
Gymnasium	0.0077	0.0026

divided above or below the reference value in Formula-A. Clearly, the existence ratio of special rooms was small if the area of school buildings was below the reference value. An exception was the principal's office that existed at 36.64% of the schools, even if the area of school buildings was below the standard value. Used concurrently as an administration office, the priority of a principal's office was high because of the need to store documents. In any case, since securing classrooms is first priority, there is a need to secure an adequate area for school buildings in advance to allow special rooms to be included.

3.5 Increase Needed Classrooms Due to the Effect of the Educational System Reform

Since the introduction of a new KG in 2016/17, great effort has been expended to completing the educational system reform. New textbooks were distributed to new Grade 1 students from 2017. New textbooks will be distributed to new Grade 6 students in 2019/20, and to new Grade 10 students in 2020/21; and the new curriculum will be applied to all grades in 2022/23. However, the primary school course from KG to the new Grade 5 will not be fully implemented until 2021/22, and facilities need to be prepared for branch primary schools and primary schools by this time. From 2022/23 to 2024/25, the middle school course will consist of three instead of the current four grades. Therefore, post primary schools, branch middle schools, and middle schools will be able to use empty classrooms for the middle school course and prepare the needed facilities by 2024/25.

A new Grade 12 will be created in 2022/23. However, the middle school course will consist of three grades until 2024/25, and the high school course will consist of two grades from 2025/26 to 2027/28. Thus, it can be increased by one grade in combination with the new

Grade 5, but all grades will be in place in 2028/29. Moreover, since the new Grade12 will be divided into selective courses, it is hoped that at least one classroom will be provided for each course.

It was then calculated how much classroom demand would eventually occur across the country by 2028/29. Seen thus far, there are no free rooms in many of the school buildings. Therefore, there is a need to discuss how school buildings will increase their area in conjunction with an increase of two grades.

3.5.1 New Grade 5

Since the volume of new Grade 5 students in the future is unknown, it was assumed that each school will have the same number of students as the current Grade 5 students. Three options were considered in the calculation. Option 1 was calculated assuming that a one unit classroom was required for 40 new Grade 5 students, and this was considered as the upper limit of the extension. For option 2, half a unit per 20 students was applied. Although there is the question of whether constructing half a unit classroom is reasonable or realistic, it is possible, for example, to create a one unit room, of which half is used as a classroom, and the rest is used as a library. Option 3 was a revision of option 2. If the number of students that increased at each school was 10 or less, students would be taught in a combined class and a new classroom was not necessary.

Figure 18 shows the average units of classroom area additionally needed to accommodate the new Grade 5 by the number of students and according to option. For option 1, it exceeded 1.0 for more than 150 students, 1.5 for more than 400 students, and 2.0 for more than 850 students. However, no matter how large the number of students, the average was about 2.5. Even for large schools, the primary school course was not necessarily very large, because the middle school and the high school courses were large. In the case of option 2, it was considerably more relaxed, and the average was 0.5 for more than 75 students, and 1.0 for more than 275 students. For option 3, it was almost unnecessary to increase the area up to 50 students, but it was nearly the same as option 2 if there were more than 200 students.

Figure 19 shows what the total is for each school size category. Even if the average unit was small, if the number of schools increased, the overall required units became larger. Based on Figure 19, it was clear that the required units were extremely high in the case of option 1 and option 2 for 26-75 students. It reflected the fact that there were many schools of this size. However, for option 3, the value was kept very low. If the total value of all schools was calculated, options 1, 2 and 3

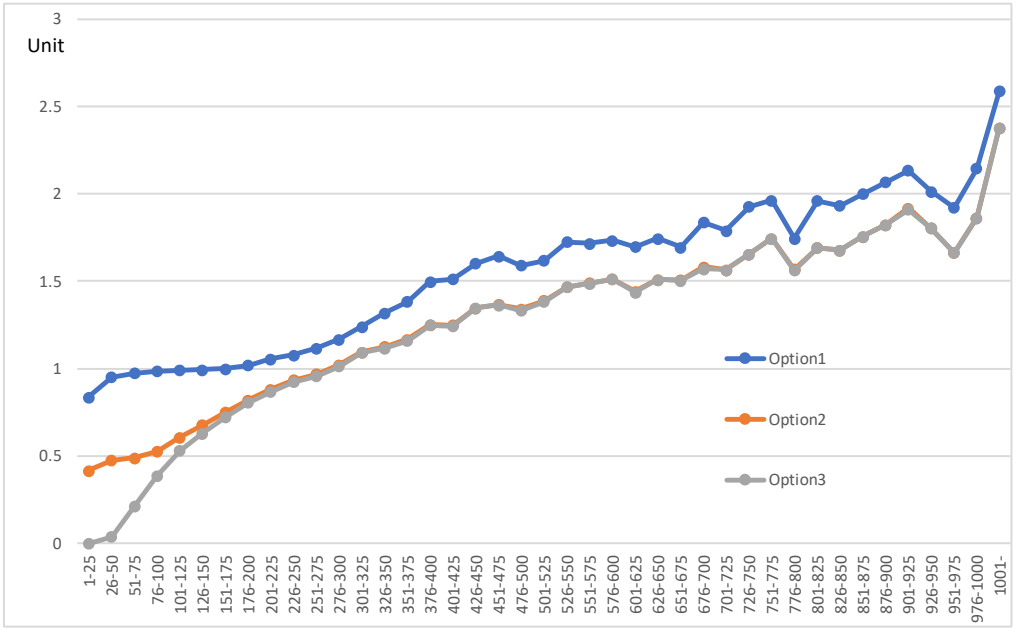

Figure 18 Average of the Additional Necessary School Building Units Due to the New Grade 5 by the Number of Students and According to Option

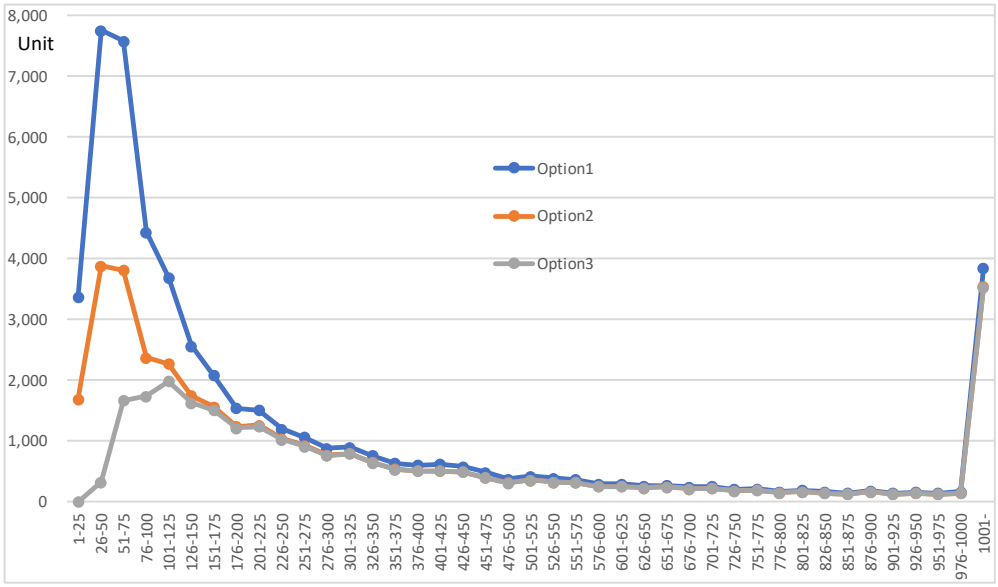

Figure 19 Total of the Additional Necessary School Building Units Due to the New Grade 5 by the Number of Students and According to Option

required 51,171.0, 34,380.0, and 25,801.5 units, respectively; and the necessary units for option 3 was half the units for option 1.

The total expanded units were 18.34% for option 1, 12.34% for option 2, and 9.28% for option 3, respectively, when compared to the area of current school buildings as shown in Table 12, new Grade 5 section. In the primary school course, since all five grades will increase by 20% due to all six grades, option 2, which showed an increase of 17.81% for primary schools was close to the present situation. Schools where children increased by 10 or less did not require new school building units in option 3. Thus, an increase in school buildings at smaller branch primary schools and primary schools can be suppressed.

3.5.2 New Grade 12

Unlike the new Grade 5, the new Grade 12 is unrelated to all the other schools; and it is an issue that concerns branch high schools and above. However, since Grade 12 will be divided into selective courses, it will be necessary to add a certain number of classrooms if a separate classroom is needed for each course, even if the number of students in each course is small. If the number of new Grade 12 students is same as the current Grade 11 students, three options were considered as in the case of the new Grade 5. Option 1 was calculated on the assumption that one unit of the school building will

Table 12 Rate of Additional Necessary School Building Units Due to the New Grade 5 and Grade 12 by the Number of Students and According to Option (%)

School type	New G5			New G12			Total			Total (Surplus considered)		
	Option1	Option2	Option3	Option1	Option2	Option3	Option1	Option2	Option3	Option1	Option2	Option3
High	5.74	5.07	5.04	17.33	15.29	14.75	23.07	20.36	19.79	12.04	10.53	10.28
High-branch	10.21	8.61	8.47	12.63	9.19	7.58	22.84	17.80	16.05	13.26	10.18	9.28
Middle	13.73	11.29	10.96	0.00	0.00	0.00	13.73	11.29	10.96	8.03	6.72	6.63
Middle-branch	16.87	13.02	12.24	0.00	0.00	0.00	16.87	13.02	12.24	10.86	8.49	8.19
Post-primary	23.90	16.72	14.36	0.00	0.00	0.00	23.90	16.72	14.36	18.26	12.70	11.13
Primary	30.80	17.81	9.83	0.00	0.00	0.00	30.80	17.81	9.83	24.39	13.62	7.40
Primary-branch	35.21	17.72	1.20	0.00	0.00	0.00	35.21	17.72	1.20	32.30	15.79	1.11
Total	18.34	12.34	9.28	5.71	4.85	4.55	24.06	17.19	13.83	16.42	11.19	8.73

be required for 40 students per course, which was considered to be the upper limit of the extension. For option 2, half a unit per 20 students was considered. The idea was that one unit can be shared by two courses if the number of students was small. For option 3, if the increased number of students was 10 or less, a new classroom was not added, and the increase was absorbed into existing classrooms, in addition to option 2.

Figure 20 shows the additional units of a school building necessary to accommodate the new Grade 12 by the number of students and according to option. As same as seen in Figure 18, if the size of a school increased, the required expansion units became larger. It became extremely large at 19 units for 3601-3800 students. This is because the premise is to prepare classrooms for each selective course as the high school course became larger. Compared to Figure 18, the difference according to option was not clear.

Even if the additional unit is large as shown in Figure 20, the required units as a whole should be small if the number of schools is small. Figure 21 shows the expansion units as a whole for each school size. All options showed the largest value for 601-800 students. In addition, the difference between the options was the most obvious in this size category. If the total value of all schools was calculated, options 1, 2 and 3 showed 15,872, 13,469, and 12,648 units, respectively; and option 3 decreased only by 79.7% of option 1. As shown in the new Grade 12 section in Table 12, school buildings increased by 17.33%, 15.29%, and 14.75% for options 1, 2, and 3, respectively at high schools. Two grades become three grades, but the reason why the value was not large like in Grade 5 was because most of the high schools included middle school courses, primary school courses, as well as special rooms.

Together with the new Grade 5 and Grade 12, 24.06%, 17.19%, and 13.83% of the current area of school buildings are required for options 1, 2 and 3, respectively as shown in Table 12. Compared to the other options, it appears possible to suppress the request for additional school buildings largely in Grade 5, and to some extent in Grade 12 for option 3. This additional demand may be absorbed to some extent by arranging the classrooms if the school building area is above the reference value. There may not be many vacant rooms at present, but it may be possible to divert a special room to a classroom. Therefore, when it is assumed that the school building area over the reference value is to be allocated as much as possible to the expansion demand for classrooms, the required additional area becomes smaller as shown in Table 12. As can be seen from Table 12, it appears that it is possible to absorb about one-third of the expansion demand, but an expansion demand of two-thirds must be met. Even if this is possible, it does

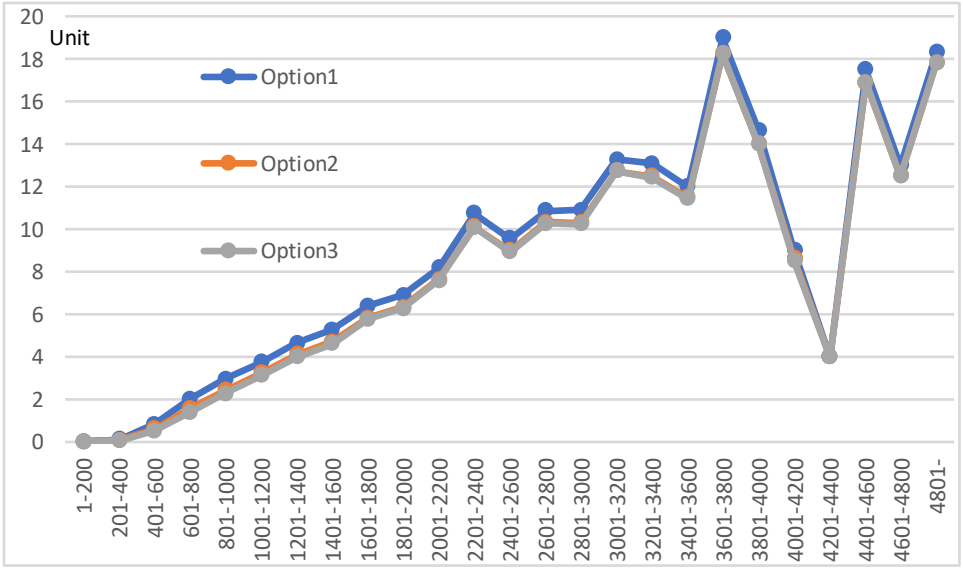

Figure 20 Average of Additional Necessary School Building Units Due to the New Grade 12 by the Number of Students and According to Option

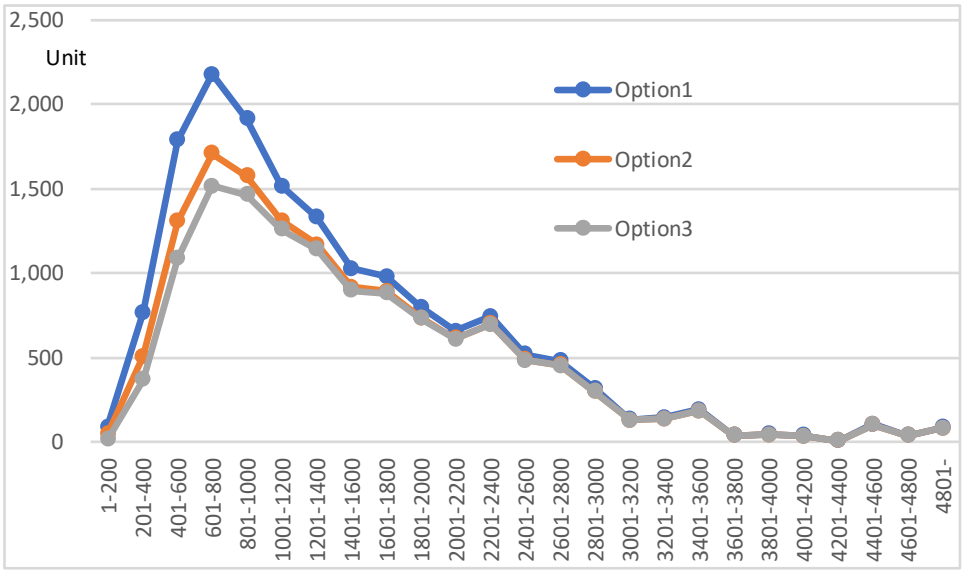

Figure 21 Total of Additional Necessary School Building Units Due to the New Grade 12 by the Number of Students and According to Option

not appear that the expansion can be completed by 2028, not only in terms of the total cost, but also in terms of the number of schools that are scattered nationwide.

3.6 Expanding the Ratio of Two-shift Schools

As a countermeasure against the shortage in school building area compared to the number of students, the first possibility is to fill up the classes as much as possible, but there is also a limit to this countermeasure. If the shortage in area exceeds a certain limit, it is natural to implement a two-shift system. There is no clear criterion when to implement a two-shift system to solve the insufficient condition of school buildings; and it depends on the circumstances of each school. However, it is reasonable to surmise that there is a high possibility of switching to the two-shift system, if a school falls far below the necessary reference area calculated based on the number of students.

Thus far, the area required for school building has been discussed based on Formula-A, a calculation of the trend value shown in Figure 5. However, some of the schools on which this calculation was based also included schools that have implemented a two-shift system. If schools that carry out a two-shift system are included in the calculation, the area of school buildings required per student is calculated to be small. Strictly speaking, the trend value should be calculated excluding the two-shift system schools.

In that case, the coefficient of the school building area per student should be larger than 18.18. For example, when a regression analysis was conducted excluding schools with 2,000 or more students that were largely considered to include two-shift schools, the coefficient for the number of students was 19.70 (Adj.R^2 = 0.6539, N = 45, 436), and when it was calculated excluding schools with more than 1,000 students, it was 19.72 (Adj.R^2 = 0.5224, N = 44, 314). Taking into account the impact of an increased number of schools with a two-shift system due to an increase in the size of the schools, it is better to use the following Formula-B which is a quadratic expression.

Formula-B: School building area (ft^2) = 21.8604 × number of students - 0.0017732 × number of students^2 + 1,325.388

(Adj. R^2 = 0.7097, Observed value = 45, 576)

The primary coefficient for the number of students was 21.86, which exceeded 20, the standard area per student shown in Figure 4, but this was understandable since a larger school has more special rooms, which was consistent with the results shown in Figure 7. Figure 22 shows trend lines based on these theoretical values. Until the number of students rose to about 2,500, there was no major difference in the area of school buildings that was estimated by either Formula-A or B.

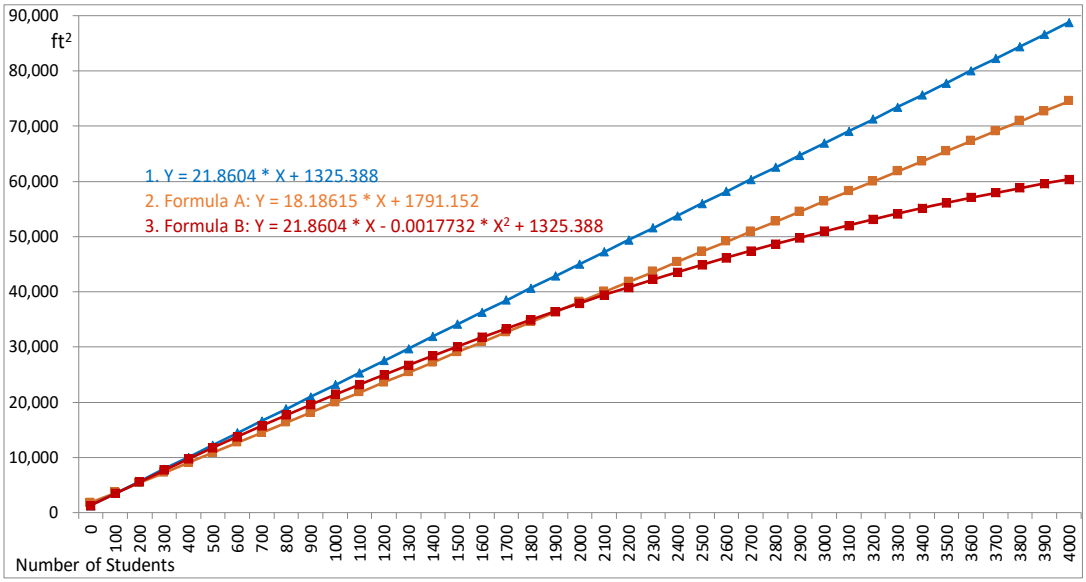

Figure 22 Trend by Theoretical Lines According to the Number of Students

As an interpretation of Formula-B, the value excluding the quadratic term for the number of students represents the area required for a school with a one-shift system. As the number of students increases, the number of schools with a two-shift system increases, and the required area of school buildings decreases by the amount indicated in the quadratic term. Therefore, Formula-1 in Figure 22 represents the standard area of school buildings for a one-shift school. However, it is still extreme to regard a school as having a two-shift system if it is slightly below this line; and a certain margin should be considered taking into account the possibility of overcrowded classes. In such cases, there may be schools where the ratio falls below a certain percentage and schools where it is below a certain number. Therefore, if the real school building area is low in comparison to the reduction of the standard school building area by 20% required in Formula-1 and the reduction of 3,600 ft^2 which is the minimum of two buildings, the possibility of a two-shift system is high. The following conditions are based on these formulas.

1) Standard area of school buildings x 0.8 > actual area of school buildings

2) Standard area of school buildings - 3,600 > actual area of school buildings

As shown in Figure 23, the proportion of schools with a high possibility of a two-shift system increases with school size, although the line was not very smooth because the number of schools decreases along with the size of the school. It appears that more than 30% of the schools implement a two-shift system when the number of students exceeds 400.

Figures 18 to 21 and Table 12 show the area required when the new Grade 5 and Grade 12 are added. If this value is added to the reference value obtained from Formula-1 in Figure 22 and the result is subtracted by the actual area, it becomes possible to evaluate how the ratio of the two-shift system changes. As shown in Figure 23, it is expected that the proportion of schools with a two-shift system will exceed 50% in the case of option 1 for schools with over 400 students. The rate of two-shift schools in option 2 and option 3 are smaller than in option 1, but if the size of the school exceeds 1,000 students, the difference in option is not large.

Table 13 shows the above calculation results by school type and according to option. Although high schools receive preferential treatment in school building area compared to the lower schools, the shortage in area is great at large schools; and there is a high proportion of schools with a two-shift system. As a result of the progress made in educational system reform, the addition of two grades contributes to an increase in the proportion of schools with a two-shift system. It is believed that the current situation will grow twofold, if the area of school buildings does not increase.

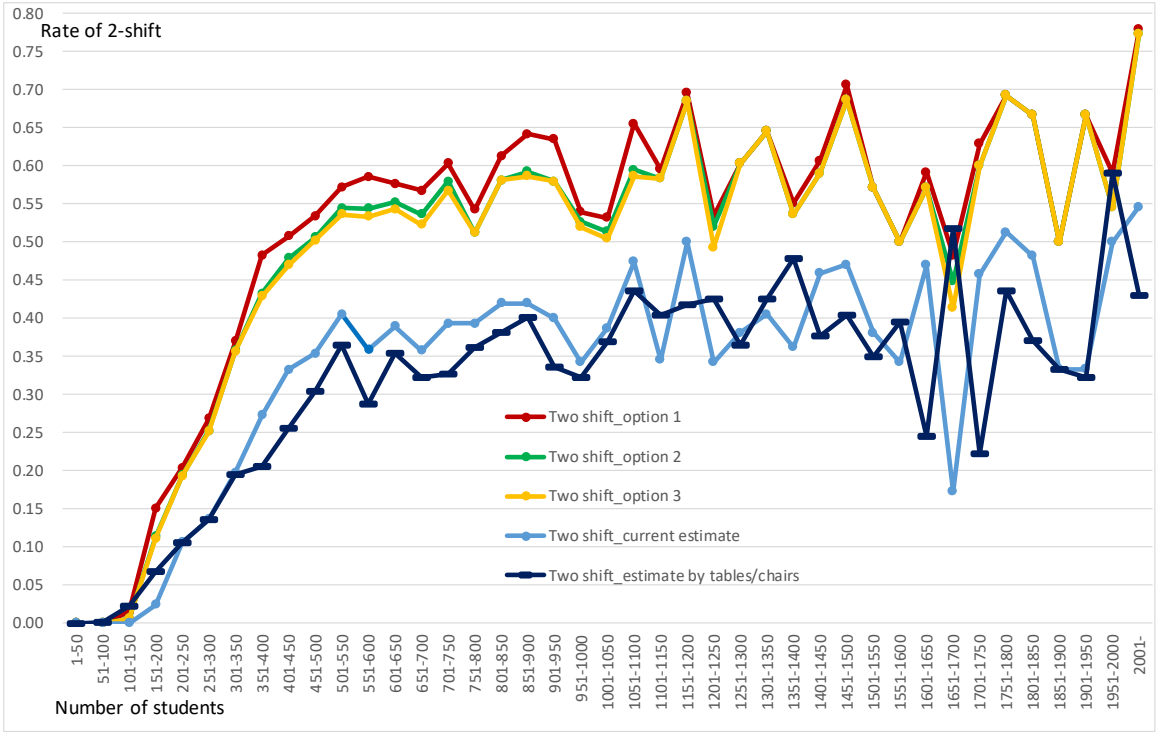

Figure 23 Ratio of Possible Two-shift Schools by the Number of Students

3.7 Validity of the Estimation

The discussion of the two-shift system has been presented based on the difference between the standard area and the actual area of school buildings. However, because the data set includes information on desks and chairs for students, this information will also be used in the calculation. There were desks and chairs for one to four students. Although it is difficult for two students to use a desk or chair meant for one student, it is possible that five students use desks and chairs meant for four students. In the case of a seat-table, chairs are not necessary. Conversely, there may be cases where there are chairs but no desks in a class. Actually, in preschool classes, there may not be any desks or chairs, but this cannot be used in the calculation, thus it was not considered.

It is possible to calculate the maximum possible number of students in a class at the same time within a school, based on the number of desks and chairs. The larger value of the number of desks or chairs was considered to be the maximum possible number of students at the school. Figure 24 shows the distribution of schools that show the ratio of desks/chairs per student. There were many schools in the 1.0-1.1

Table 13 Rate of Two-shift Schools by School Type and According to Options

School type	Current	Option 1	Option 2	Option 3	Tables/ chairs
High	0.2526	0.4541	0.4295	0.4242	0.2732
High-branch	0.2710	0.4650	0.4223	0.4060	0.2431
Middle	0.1736	0.2640	0.2531	0.2531	0.1603
Middle-branch	0.1373	0.2284	0.2149	0.2145	0.1162
Post-primary	0.0962	0.1756	0.1585	0.1582	0.1011
Primary	0.0125	0.0285	0.0252	0.0250	0.0159
Primary-branch	0.0024	0.0040	0.0032	0.0028	0.0038
Total	0.0694	0.1232	0.1136	0.1126	0.0687

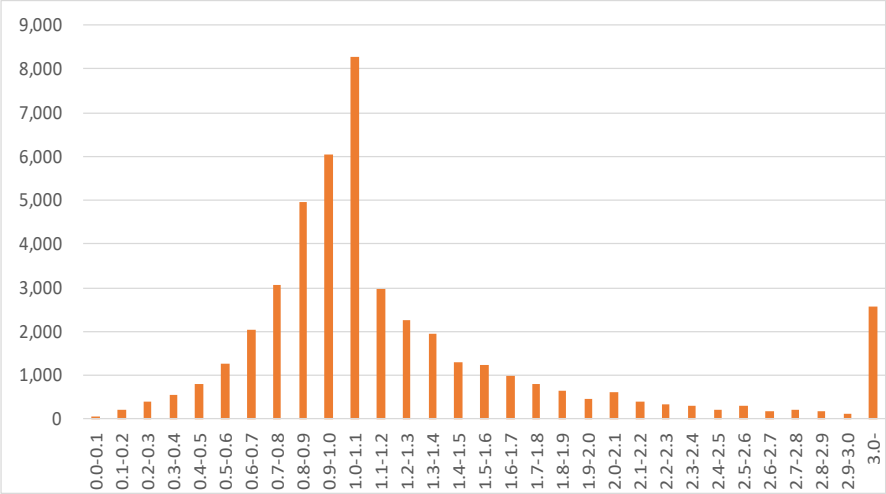

Figure 24 Distribution of the Nominal Capacity Ratio of Table/Chair per Student

category, but there were many schools that showed even higher values because spares desks and chairs as well as desks and chairs used in special classrooms were also included in the calculation.

The problem is when the number of students is larger than the number of desks/chairs. Assuming the possibility of overcrowded classes, the possibility of a two-shift may be high if the value was less than 0.9 in Figure 24, and the subtracting value of the number of desks/chairs from the number of students is more than 80, which is the standard number of students for two classes. When written according to the formulas, the following conditions were met.

1) Upper limit of desks/chairs <Number of students x 0.9

2) Upper limit of desks/chairs <Number of students - 80

The proportion of schools with a two-shift system based on such premises are also shown in Figure 23 and Table 13. Although there were minor differences, it was similar to the ratio of schools with a two-shift system estimated from the area of school buildings as a whole.

The possibility of a two-shift system was discussed from physical and restrictive situations such as the area of school buildings and the number of desks/ chairs compared to the number of students. The estimated possibility of a two-shift system was strictly carried out, but the actual situation is probably higher than the figure indicated here; and it may be underestimated. Specifically, since the margin was large, the ratio of schools with a two-shift system may be larger than what is shown in Figure 23 especially for small schools.

4. Conclusion and Policy Implications

4.1 Conclusion

Looking at the distribution of schools from the number of students, there were many extremely small schools where less than 100 students accounted for 53.02% of the total. Even schools with 450 students or less accounted for 90.03%. In contrast, there were also huge schools with 2,000 or more students, but they were few in number. Even if the number of students was small, a minimum size school building is necessary. It was 136.7 ft^2 per student for 1-25 students, but 20.3 ft^2 per student if there were more than 1,000 students. Even if the number of students was not so extreme, it was 76.8 ft^2 per student for 76-100 students, but only 28.9 ft^2 per student for 176-200 students, which was only 71% per student. It becomes efficient accordingly. If the size of a school is small, it is difficult to make even a principal's office or teachers' room, not to mention special rooms such as a library.

The ratio and extent of special rooms were examined. Regarding the existence of special rooms, variables/ categories were examined that were highly explanatory when regressed by the year a school was established/ upgraded, the rank of a school, and the school type. As for the existence of special rooms, there was also a problem of functionality as a facility, and at least half a unit, usually a one unit room, was prepared. There were

cases of two or more laboratories in a school or a three units wide gymnasium. However, the ratio of such schools was generally low. The principal's office and teachers' room are necessary to improve the efficiency of the school's operation. The library, computer room, laboratory, LL, media room, and gymnasium are needed to enhance the effectiveness of education.

However, many schools had none of the special rooms. Although it is understandable that 85.7% of branch primary schools and 60.6% of primary schools did not have any special room, there was no special room at 18.1% of middle schools and 2.8% of high schools. When the principal's office and the teachers' room were excluded and only "special rooms for education" were considered, 16.7% of high schools and 45.1% of branch high schools had neither a library nor a laboratory. Of course, it is possible that these special rooms were underestimated due to data constraints, but there were only ordinary classrooms; and it was wondered how subjects that required experiments, etc. were taught. It is worrisome that students only memorize textbooks in such subjects.

The rank of a school and the year a school was established/upgraded had their own impact on the existence of special rooms, according to the results of the regression analyses. Schools with good access that were close to TEO and established schools had a high ratio of special rooms. Muta [1] [2] [3] [4] showed that the number and quality of teachers were high at these schools, but educational conditions were also blessed in terms of facilities. Thus, educational conditions differed from school to school, and this is problematic from the viewpoint of equal educational opportunities.

If two more grades are added by the educational system reform, it is estimated that up to 24.06% of school building area will be needed compared to the present situation. It is necessary to construct this increment within the necessary time period. But if this is impossible due to the cost and the construction period, the introduction of a two-shift system is inevitable even temporarily. The two-shift system is currently used in large schools in general. Even if the number of students is not large, there were a certain number of schools that was supposed to implement a two-shift system due to a shortage in school building area. Due to the increase of two grades under the educational system reform, the number of schools implementing the two-shift system is expected to significantly increase further. In contrast, this is a good opportunity to think about efficient and effective school configuration plans as a large amount of school building expansion should be carried out.

4.2 Policy Implications

From the above results, the following policy implications were derived.

1) It is necessary to enrich education with special rooms.

In addition to the school principal's office and teachers' room, it is necessary to secure the space necessary to create a library, laboratory, computer room, LL, media room, gymnasium and other facilities, in addition to classrooms to enrich school education. It may be necessary for the school to be of a certain size for the provision of these special rooms, but measures should be taken as much as possible to create such special rooms.

2) If necessary, implement a two-shift system that can respond to actual need.

There is no doubt that the number of students will increase due to the addition of two grades due to the educational system reform, and it will be necessary to expand the area of school buildings accordingly. However, it is doubtful whether all necessary new construction can be finished in a short period of time. Pessimism is inevitable when materials and construction period, in addition to the cost are considered. Thus, it is realistic to introduce a two-shift system at many schools and to use the school building efficiently. Of course, instead of fixing the two-shift system, efforts to restore the original one-shift system after completing the necessary classroom expansion must be completed as soon as possible.

3) It is necessary to consider proper placement of the school with an efficient size.

According to previous studies, schools are unnecessarily and densely built depending on the region [5] [6] [7]. Although each school was constructed under different historical circumstances,

the merging and consolidation of schools is not easy, but the current situation leads not only to inefficient use of teachers, but also the inefficient use of school buildings. When the addition of classes or the rebuilding of schools is planned, the possibility of merging and consolidating neighboring schools should be considered in order to use valuable educational resources such as school buildings and teachers more efficiently. It should not be assumed that the present situation is fixed, and that all schools must be expanded in the same way.

4) It is necessary to formulate a long-term school configuration plan.

To improve the quality of education, the learning environment is just as important as teachers. Presently, there are only classrooms, but no special rooms. Thus, even if a school is upgraded to a higher level school, the provision of needed school buildings lags. Flexible classrooms that do not have walls and can be partitioned with screens make it possible. By defining the general parameters, it is possible to calculate how many students at each school increases and how many classrooms are necessary in a certain period, if we know how many children in the region changes in the future. Even though it cannot be realized immediately, it is necessary to make a long-term school configuration plan as part of a regional education plan, and to establish achievement targets for each fiscal year to make steady improvements to the plan every year.

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Abstract（Japanese）

幼児児童生数規模から基礎教育学校の分布を見ると，半数以上は100名以下の学校で、極端に小さな学校が多い．しかし，学校規模が小さければ，図書室，コンピュータ室，実験室，LLなどの特別室はおろか，校長室，教員室の捻出もままならない．学校規模の小ささが校舎の効果的，効率的運用を阻んでいる．

回帰分析の結果からも，TEOに近いアクセスの良い学校や古い学校は特別室の存在割合も高い．以前の分析でこれらの学校では教員の数や質が高い事を示したが，施設面からも教育条件が恵まれている．このように，教育条件が学校によって異なっているのは，教育の機会均等を考える上で問題である．

学制改革によって小学校課程と高校課程でそれぞれ1学年増える．このため，新たな教室が必要になる．新たな学年の人数が少なくとも，1ユニットの校舎を増設するとなると，現在の全学校の校舎を最大24.06%増しにしなければならない．増加人数が少なければ，新しいスペースを用意せず，その他は必要最小限の施設を用意するにしても，13.83%の増加が必要である．これを新学制が完成する2028年までに完成することは費用的にはもちろんのこと，工期，学校数の多さを考えれば不可能に近い．優先順位を決めて，校舎増設を着実に施工するとしても，多くの学校で，一時的に2部制を新たに実施せざるを得ない．他方，大幅な校舎増設を機会に，効率的効果的な学校配置計画を考える好機とも考えられる．

Key words：学校施設，2 部制，特別教室，学級不足，学制改革

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