

A STUDY ON SPACE CONFIGURATION OF ELEMENTARY SCHOOLS AND CHILDREN ACTIVITY IN FREE TIME

AUTHOR: **Mayuko TAGUCHI**
Graduate school of Science and Technology, Keio University, Japan
e-mail: parsifal918@yahoo.co.jp

Tatsuya KISHIMOTO
Department of System Design Engineering, Keio University, Japan
e-mail: kishimoto@sd.keio.ac.jp

KEYWORDS: *Elementary School Building, Children's Activity, Distribution, Territoriality, Convex Analysis*

THEME: Building Morphology and Usage

Abstract

Elementary school building is the place where pupils spend most of the day, not only studying but also playing freely. In recent years, the Japanese government has attempted to make more motivating design for children and many elementary school plans have been tested; creating layouts that promote communication between grades, conversion of unused rooms and creating new type of spaces, but on the other hand, some of these plans do not utilize unexpectedly. In order to create environment to encourage children to learn by themselves, it is important to recognize where and what children do during their free time by means of revealing the relationship between children activities and space configuration for the school building design and plans.

There are former researches, which investigates the effects of physical environment on children behaviors in elementary schools. But, there are few studies which analyzed the relationship between spatial configuration and children distribution.

The purpose of this paper is to get a handle on children activities in the whole elementary school building and to reveal the effects of spatial configuration on children activities based on space syntax theory. In order to this attempt, we compare the correlation between observation data of children activities and the spatial property derived from space syntax theory. Through this we attempt to discover the helpful tip for the creation of environment to encourage children activities.

Three stages of study were separately conducted. In the first stage, we selected three different types of elementary schools in Japan, where we observed children activities during recesses between lessons. In the second stage, space configuration was analyzed using step depth, integration value, and justified graph through the convex analysis. In the final stage, we analyzed the relationship between the space syntax indexes and pupils' distribution data and children activity data. The outcome of this analysis comes that correlation between depth from classrooms and children territoriality were found. Distribution of the lower grades has strong relationships between depths and concentrated around classrooms while children in the higher grades are less affected by depth and their territory is large.

The study shows relationships between space configurations and children activities, and also the space syntax theory can estimate distribution of children and elementary school buildings plan. It is concluded that analysis based on the space syntax analysis can be applied to recognize the children activities and is useful for elementary school planning.

1. INTRODUCTION

1.1. Background

Many factors have changed in elementary school design over the past decades, as government has attempted to make more comfortable and more motivating design for children. The elementary school building is the place where pupils spend most of the day. The pupils are forced by law to spend in the elementary school for six years, 210-240 days a year during the impressionable time in their life. In recent years, elementary school building is becoming the place where pupils not only study but also play freely and the emphasis is on activities during the free time. Such trends have induced necessary to build up environments for children to foster the ability and willingness to learn independently. These independent factors of learning are that encourage children to make the most of their individuality and stimulate a variety of activities.

To build up environment to encourage children to learn by themselves not only in classes but also in free time, many elementary school plans have been tested; creating layouts that promote communication between grades, conversion of unused room, creating new type of space and so on. On the other hand, some of these plans are not fully developed.

1.2. Related Studies

There are various researches about elementary school building. Ueno, et al (1994) studied about recent architectural planning of elementary and secondary schools that contain the multi-purpose spaces. The research showed that many multi-purpose spaces are unrelated and unsociable. They pointed out that unlike its original role to use in daily activities and contribute to the living space, those multi-purpose spaces decrease the activity of the whole school space.

Yanagisawa, et al (1991) investigated the effects of physical environment on children behaviors in elementary schools. The survey is based on the observation of children behavior. The result shows that most of children occupy the prior territory with some friends. But if this space is small, children sometimes spread over to public spaces or neighbor places. The children who occupied isolated place usually make a small intimate group. Yanagisawa pointed out that the needs for spatial configuration, square meters of spaces and setting corners.

There are many studies about children activities that researched just where and what children do. In addition, there are no studies that analyzed the relationship between spatial configuration and children distribution. This study compares children distribution to the analysis of space.

Saif Haq (2002) studied correlation between cognition and configurational properties in three large urban hospitals. Correlational and regression analyses revealed that, although use of space was best predicted by connectivity, distribution of people was better explained through local integration. In addition, although global integration is a good predictor of people when the general presence is mapped, local integration is the most important predictor for exploring and wayfinding people in new setting. There are many spatial analysis studies using space syntax in cities, houses, museums, etc., but there isn't for the elementary school yet.

1.3. Purpose

It is important to figure out what kind of place is used and what kind of activities children carry out in the elementary school by observing children activities in the free time. Most of the previous studies about children activities in free time limits target to a part of building and does not analyze the effects of spatial configuration on children distribution. Expressing quantitatively how the physical influence of the building extends to the behavior patterns of children, it would become useful knowledge for future elementary school planning.

The purpose of this paper is to get a handle on children activities in the whole elementary school building and to reveal the effects of spatial configuration on children activities based on space syntax theory. In order to this attempt, we compare the correlation between observation data of children activities and the spatial property derived from space syntax theory. Through this we attempt to discover the helpful tip for the creation of environment to encourage children activities.

2. OBSERVATION OF CHILDREN ACTIVITY

2.1. Case study

The research was carried out in three elementary schools in Japan: Iniwano elementary school, Ashiwara elementary school, and Miyamae elementary school. Iniwano elementary school has three buildings: gymnasium building, specific classroom building, and classroom building. Each building is independent and children move to each building through two bridges. There are three types of classroom unit-plan that surround a central zone of a library. Unit-plans of the lower grades classrooms are on the ground floor and have each entrance. Unit-plans of the middle-higher grades are on the ground and first floor and surround a central zone of court. Ashiwara elementary school is three-story building. The lower grades classrooms are on the ground floor and the higher grades classrooms are on the second floor. On the first floor, there are specific classrooms where children can communicate between grades. Children are allowed to enter the roof terrace with biotope space. Miyamae elementary school has three unit-plans of classrooms on the first floor. Each class has one terrace that connects to the court on the ground floor. Classrooms are divided into three unit-plans: unit-plans of the lower grades, the middle grades, and the higher grades. They are located in parallel.

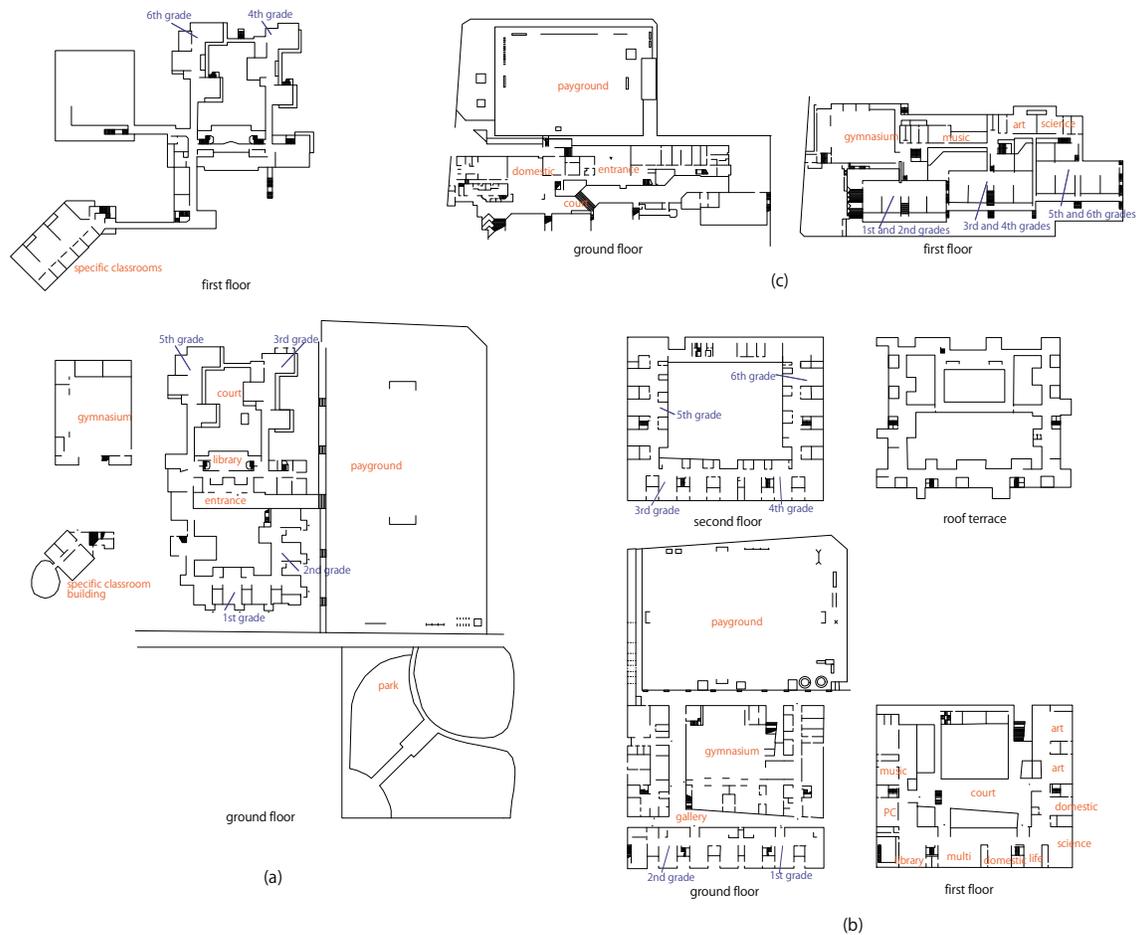


Figure 1. School plan [(a) Iniwano, (b) Ashiwara, (c) Miyamae]

2.2. Method

We interviewed teachers which free time is children have the most time to play freely because time slots are differ depending on schools. According to this interview, we investigated the actual children distribution in free time at Iniwano for 25 minutes, at Ashiwara for 20 minutes, and at Miyamae for 20 minutes.

Children sometimes prepare for the next class and sometimes the previous class extends. In this research, we regard those 5 minutes, before and after the free time, as the preparation time and did not review in the survey. For example, in the case of 25 minutes free time, surveyed time is 15 minutes setting apart five minutes of the beginning and the end. We observed children activities at each school by taking video record. For recording purpose, three to five researchers walked around the entire of the grounds of school taking video record. We collected distribution data and activity data from video record and interview.

2.3. Children distribution in free time

The recorded data were then manually written into children distribution maps and children activities were also written into maps. With differences in locations of classes between grades, we defined first and second

grades as the lower grades and from third to sixth grades as the higher grades. In this paper, places where children stayed are roughly divided into 11 area; classroom, open space, playground, court, outside, library, corridor, specific classrooms, gymnasium, roof terrace, and corner.

In Iniwano, most of the children stayed at classrooms, the playground, the park, and open spaces in front of classrooms (see table 1). Children at open spaces belong to classes next to there and they didn't go to open spaces of other grades. The domain of children in the lower grades and the domain of children in the higher grades were separated except the library and the court. Few of the children were in a specific room building and a gymnasium building.

Table 1. Percentage of the children distribution

		(%)										
		classroom	open space	playground	court	outside	library	corridor	specific classroom	gymnasium	roof terrace	corner
Iniwano	all children	34.53	11.63	33.81	2.33	4.47	3.76	5.37	1.07	1.43	-	1.61
	children of the lower grades	37.95	11.45	37.95	4.82	2.41	2.41	3.01	0	0	-	0
	children of the higher grades	33.08	11.70	32.06	1.27	5.34	4.33	6.36	1.53	2.04	-	2.29
Ashiwara	all children	19.46	16.76	13.87	6.36	4.05	3.28	17.73	4.43	7.9	2.89	3.28
	children of the lower grades	32.85	14.60	11.68	13.14	10.22	0	9.49	2.19	0	0	5.84
	children of the higher grades	14.74	17.63	14.74	3.95	1.84	4.47	20.26	5.26	10.79	3.95	2.37
Miyamae	all children	28.21	6.92	22.31	12.05	11.79	0.77	14.10	2.31	1.54	-	0
	children of the lower grades	39.75	10.56	12.42	8.70	13.04	0	15.53	0	0	-	0
	children of the higher grades	20.09	4.37	29.26	14.41	10.92	1.31	13.10	3.93	2.62	-	0

In Ashiwara, most of the children stayed at classrooms, open spaces in front of classes, the playground, open spaces on the first floor, and the gymnasium. 98 percent of the children in the lower grades stayed on the ground floor especially in and around their classrooms, the playground, and gallery. They didn't go to areas where children in the higher grades stayed, except the playground. Compared to the higher grades, they tended to stay within limited area. On the other hand, children in the higher grades stayed at every area of the building, and about 42 percent of children were on the second floor where classrooms locate.

In Miyamae, most of the children stayed at classrooms, the playground, and the court. Most of the children in the lower grades stayed at classrooms (39.75%). On the other hand, most of the children in the higher grades stayed at the playground (29.26%). More than half of children in the higher grades stayed outside.

The distribution of children was highly dense at near classrooms, the playground, and the park in each school, especially at classrooms. 22 percent of children in Miyamae were in classrooms located on the first floor and 21 percent of children in Iniwano were in classrooms located on the ground and first floor. On the other hand, few children stayed at the playground in Ashiwara where classrooms are located on the ground and second floor (14%). The closer classrooms to the playground, the more children go to the playground.

For children of the lower grades, 24 percent of children stayed at the playground in Iniwano where classrooms are on the ground floor and have entrances that connect to the playground directly. On the other hand, 12 percent of children stayed at the playground in Ashiwara where classrooms on the ground floor and children must go to the playground through the gallery.

The extents of the children in the lower grades were small in each school. Compared to the children in the higher grades, lower grades children tend to stay within small area near their classrooms. Children enlarge their scope of activities as they grow.

2.4. Children activity in free time

We investigated children activities in the free time in three schools and 26 types of activities were observed. These activities can roughly divided into four groups; passage, studying and living, dynamic, and static activities .

Table 2. Percentage of children activities

(%)

	passage	studying and living	dynamic	static	all
Iniwano	8.05	27.19	37.75	27.01	100.00
Ashiwara	17.57	12.16	36.29	33.98	100.00
Miyamae	12.56	17.69	47.18	22.56	100.00

- **Moving activity**

Children engaged in their activities stay in certain places like the classroom, the playground and the open space. Other children are moving toward next place where they will engage in activities. In this paper, such activities are called as moving activities. Most of moving children were observed in open spaces and corridors especially the place between classrooms and the playground in each school. Many children come to these places.

- **Studying and living activity**

Some teacher continued teaching during freetime and some of children were in classrooms with the remaining assignments and some children prepare for the class. We found such children who could not perform as they like in the free time due to the school curriculum. In this study, such activities are not included in free action and they are called the studying and living activities. These activities were observed in classrooms and open spaces. Children studied in their own class and practiced in music room and gymnasium. Preparing children were around classrooms with restrooms and tool place. Studying and living

activities force children what to do in the free time. Therefore they force children where they do in the free time automatically.

- **Dynamic activity**

There are two types of free activities of children; dynamic activity and static activity. Dynamic activity is strenuous movement such as sports. The number of children who carried out dynamic activities was the largest group in all schools. These activities were observed in the playground, the court, and sometimes in classrooms. It was at the outdoors with large space where many children stayed and engaged in dynamic activities.

- **Static activity**

Static activity means moveless activity such as reading a book in the library and chatting with friends. Some of children were observed in the particular place such as the court and the biotope. The major activity of static activity was chatting that seen in the classrooms frequently. Many children were chatting with several friends at empty and quiet place such as the corner of open spaces and a roof terrace. Some of the children who wander aimlessly were observed around classrooms. There were some children who just watch other children activities and the scene without participating any activity from their own motive. These children were engaged in static activities tended to stay away from other children.

Distribution research showed that the distribution of children was highly dense at the playground and classrooms during free time in the three schools. Closer distance between the playground and classrooms, more children go to the playground. There were highly dense children distribution around classrooms compared to that there were few children far distance from classrooms. Children in the lower grades tended to stay in small areas near the classrooms and few of them stayed at distant locations. On the other hand, children in the higher grades stayed everywhere in school building, mainly around classrooms and the playground.

Children activity research showed that the most activity was dynamic activity outside, such as the playground and the court in three schools. Second is static activity that children stay at quiet places with a few children. Studying and living activity observed at the classrooms and at the specific rooms. Moving activity was observed mainly at open spaces and corridors that are at central positions of the building.

3. SPATIAL ANALYSIS

3.1. Method of convex analysis

Space syntax is a kind of technique used to identify and analyze space. It describes the layout of spaces in terms of relational pattern. Such configuration analysis techniques allow a detailed description of any buildings in terms of the structure of space. Using space syntax methods, the spatial characteristics in elementary school layouts can be traced.

In order to make convex maps of the three schools, the whole spaces including playgrounds and courts without places where children usually don't use are divided into convex spaces. Space configurations were analyzed by convex analysis and expressed by two indexes: integration and step depth, and justified graphs. Graphviz made justified graphs.

3.2. Step depth from classrooms

We obtained step depth from classroom where children based in during their school life. We obtained two types of step depth: for the higher grades and for the lower grades (figure 2).

The results of step depth in Miyamae show not much difference between the higher grades and the lower grades. The results of the other two schools shows quite difference between the higher grades and the lower grades. Classrooms of the lower grades, close to the playground compared to classrooms of the higher grades, are far away from the playground in both schools. Three school results have one common feature that each step depth of grades is medium degree at the center of the school building. The entrance and around the library in Iniwano, the first floor in Ashiwara, and the court and around the entrance have medium degree of step depth to both classrooms of the higher grades and the lower grades. That is, centrally-located spaces in school buildings lie midway between the higher grades and the lower grades.

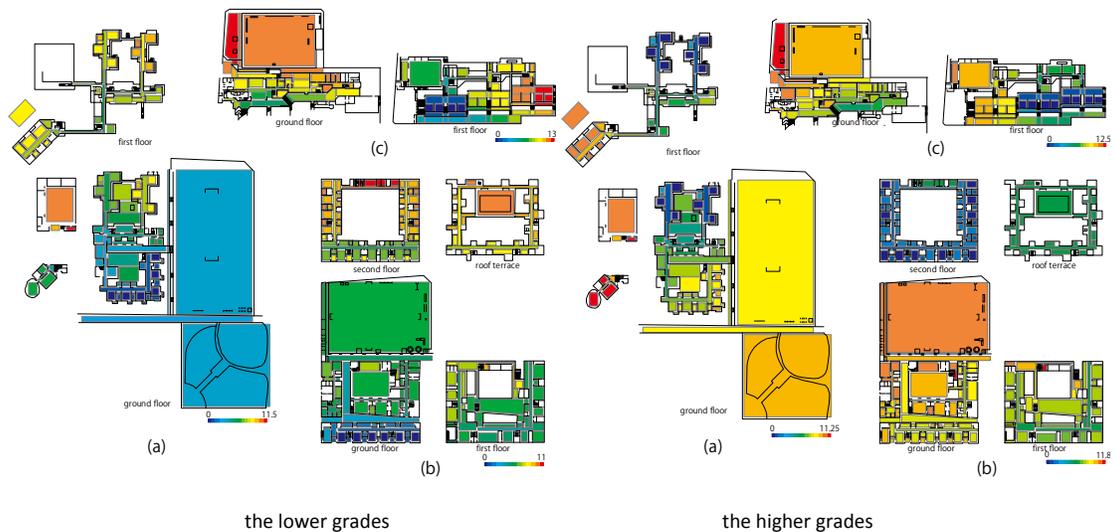


Figure 2. step depth to classrooms [(a) Iniwano, (b) Ashiwara, (c) Miyamae]

3.3. Integration

The result of Iniwano shows that integration is focused around the library and in corridors in the heart of the school (see figure 3). Meanwhile, the gymnasium and the specific classroom building are segregated. The result of Ashiwara shows that integration is focused in open space in front of classrooms of the lower grades on the ground floor, open space in front of specific classrooms on the first floor, and open space in front of classrooms of the higher grades on the second floor. The gymnasium and specific classrooms are not so segregated in Ashiwara compared to Iniwano. In the integration map of Miyamae, high integration values are concentrated around the court and the entrance in the heart of the school. Nevertheless, gymnasium and specific classrooms are segregated in Miyamae and that is the common feature of the three schools.

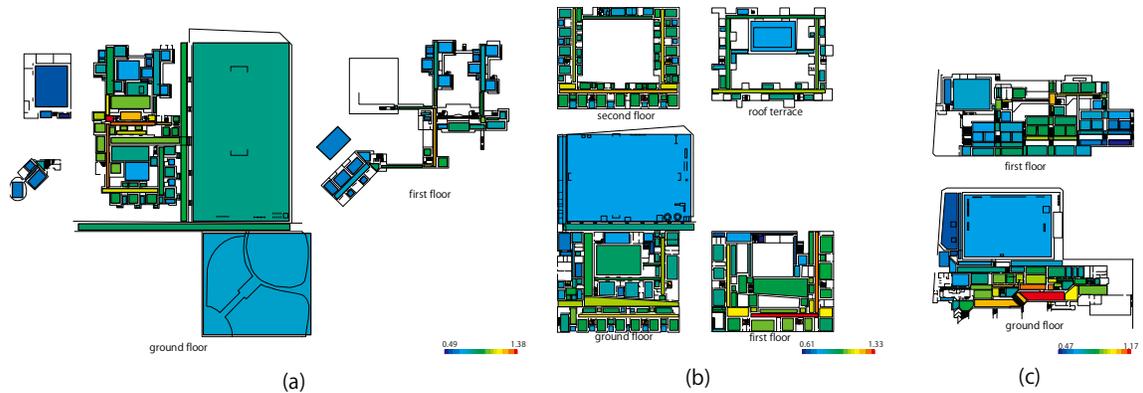


Figure 3. integration map [(a) Iniwano, (b) Ashiwara, (c) Miyamae]

3.4. Justified graph

We expressed children distribution by color-coded nodes using justified graphs that express space connections of school building (figure 4). The results of justified graph from the playground where children distribution is highly concentrated in every school are shown respectively.

We can see the spatial connection and children distribution more clearly by examining the justified graphs. Justified graphs show that both children distribution of the lower grades and the higher grades were highly dense around classrooms and the playground. There are many children in spaces connecting to classrooms or the playground. Meanwhile, there are few children around ends of the graphs. Results show clearly that there are many children between classrooms and the playground.

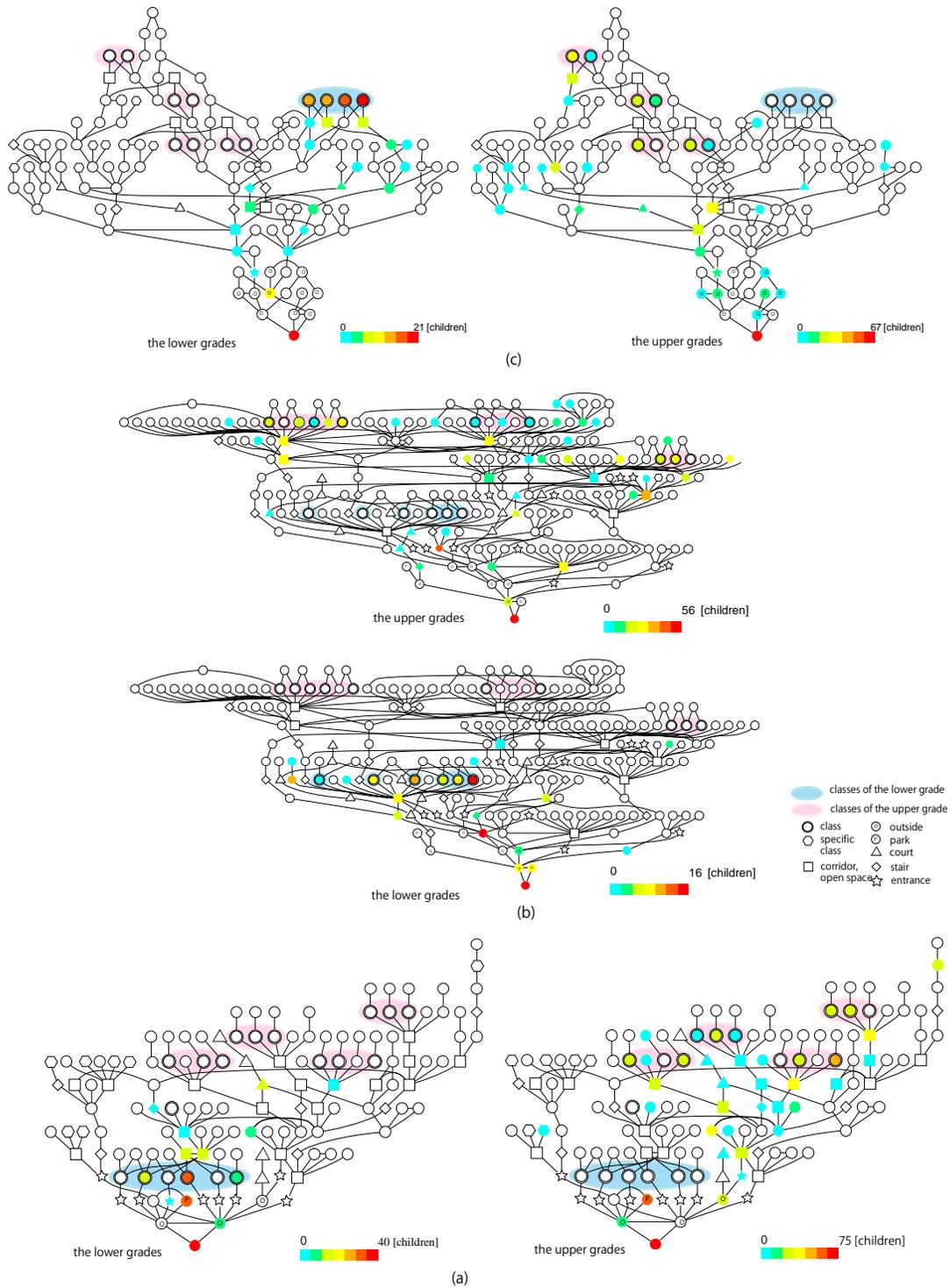


Figure 4. justified graphs from the playground [(a) Iniwano, (b) Ashiwara, (c) Miyamae] with children distribution expressed

4. COMPARISON OF CHILDREN ACTIVITY WITH SPATIAL CONFIGURATION

4.1. Correlation between children distribution and indexes

Comparing children distribution with convex analysis indexes, integration and step depth from classrooms, we revealed how spatial configuration affects to children activities. We counted the number of children in each convex space and compared to each index.

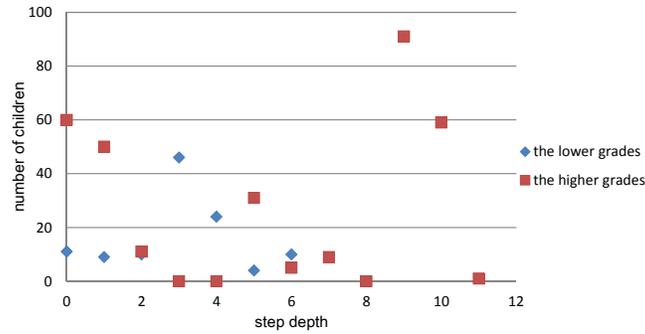
Table 3. Correlations between spatial variables and number of children

	Iniwano		Ashiwara		Miyamae	
	correlation	p-value	correlation	p-value	correlation	p-value
Integration and all children	0.043	0.616	0.063	0.349	-0.055	0.520
Step depth and children in the lower grades	-0.300	0.000	-0.405	0.000	-0.435	0.000
Step depth and children in the higher grades	-0.117	0.168	-0.090	0.182	-0.027	0.757
Step depth and all children	-0.164	0.006	-0.167	0.000	-0.177	0.003

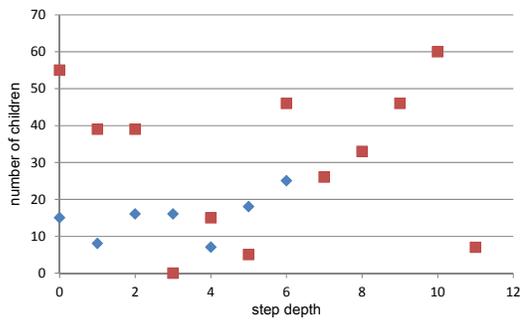
In all schools, correlations are founded between all children distribution and step depth, and between distribution of the lower grades and step depth (see table 3). Furthermore, distribution of the lower grades has the strongest correlations in each school. On the other hand, the correlations between distribution and integration, and between distribution of the higher grades and step depth, are poorly correlated with each other.

These results show that integration, in other words spatial centrality, doesn't affect to children distribution. In contrast, step depth from classrooms showed negative correlations with distribution that is the farther from classrooms, the fewer number of children. There are stronger negative correlations between step depth and distribution of the lower grades compared to the higher grades. Figure 5 shows clearly that children in the lower grades tend to stay at places where step depth is small to classroom, compared to children in the higher grades.

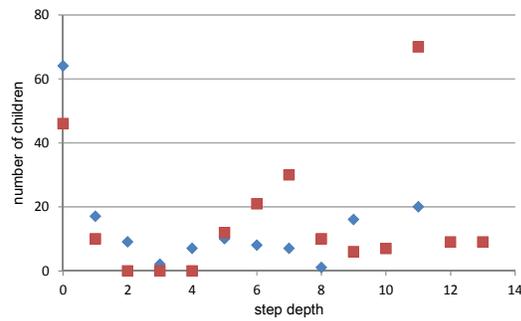
Calculating the step depth from classrooms in three schools, it is seen that larger mean step depth from classrooms was given in the higher grades compared to the lower grades (3.01, 5.49, 3.39, 5.43, 3.65, and 6.98 of the lower grades and the higher grades in Iniwano, both of grades in Ashiwara, and both of grades in Miyamae, respectively; see table 4). The maximum of the step depth was about twice larger in the higher grades than in the lower grades. Since the step depths of the higher grades vary widely, the standard deviation was also larger in the higher grades than in the lower grades. In sum, these results show that distribution of children in the lower grades tend to be highly dense around classrooms and less dense in faraway places from classrooms because they are strongly influenced by distances from classrooms. On the other hand, children in the higher grades are not influenced by distance so much and they expand their range of activities.



(a) Iniwano



(b) Ashiwara



(c) Miyamae

Figure 5. Scatter gram of step depth and distribution

Table 4. Summary of step depth from classrooms

		number of children	mean step depth	maximum step dpeth	standard deviation
Iniwano	the lower grades	114	3.01	6	1.55
	the higher grades	161	3.65	11	4.09
Ashiwara	the lower grades	105	3.39	6	2.12
	the higher grades	371	5.43	11	3.75
Miyamae	the lower grades	161	3.65	11	4.09
	the higher grades	230	6.98	13	4.40

4.2. Relationship between children activity and indexes

To reveal the effects of space configuration on children activities, we compared the number of children who is engaged in each activity. We classified them into four groups: passage, studying and living, dynamic, and static activity. In addition we calculated indexes of each space that classified into 11 groups. Indexes of each space were based on averages of all spaces of the group. These indexes give the numerical data that arranged in ascending order (see table).

As seen in the data table5, the library is the most integrated space in Iniwano, followed by corridors (1.11), outside (0.95), and open spaces (0.91). The most segregated space is the gymnasium (0.54), followed by classroom (0.78), and the playground (0.79). The smallest step depth to the classrooms spaces are of course classrooms (0), followed by open spaces (0.79), and corners (3.3). The biggest step depth space was the gymnasium (10.0), followed by specific spaces (8.50), and the playground (7.25).

Figure 6 shows that in Iniwano, the distribution of moving children tend to be highly dense at open spaces, corridors, and outsides, where integration values are high. Most of the children who are engaged in studying and living activities tend to stay at classrooms and some of them tend to stay at open spaces, specific classrooms, and the gymnasium. The commonality of these spaces is segregating. Classrooms and open spaces have small step depth to the classrooms compared to specific classrooms and the gymnasium has the large step depth. Most of the children who are engaged in dynamic activities tend to stay at the playground. Although the playground has small integration value and large step depth from classrooms, most of the children were observed in the playground. Children who are engage in static activities are everywhere for example classrooms, open spaces, the library, the court, and corners. These spaces have small step depth from classrooms.

In Ashiwara, the results show that the open spaces are the most integrated spaces (1.06), followed by specific classrooms (0.98), and classrooms (0.95). The most segregated spaces are the library and the playground (0.78) and followed by the outside (0.85). The differences of integration of each space are small in Ashiwara. The smallest step depth spaces are classrooms (0), followed by open spaces (1.63), and specific classrooms (5.26). The largest step depth space is the library (10.4), followed by the gymnasium (9.50), and the playground (9.42). Most of the moving children are on open spaces and corridors with large integration values. Children who are engaged in studying and living activities are mainly in classrooms, open spaces, and specific classrooms with small step depth. These results are common in Iniwano. Compared to dynamic activity concentration in the playground in Iniwano, dynamic activity in Ashiwara is diverged in various spaces like the playground, open spaces, and the gymnasium. The static activity is also diverged in various spaces but especially in classrooms.

In Miyamae, the most integrated space is the court (0.99), followed by corridors (0.90), and specific classrooms (0.82). The most segregated space is the gymnasium (0.65), followed by the playground (0.65), and the outside (0.68). The smallest step depth spaces are classrooms (0), followed by open spaces (1.00), and the court (6.69). The largest step depth space is the playground (10.6), followed by the gymnasium (10.5), and the outside (9.17). Much moving activity is at corridors and open spaces with high integration value in common with other two schools. Other activities are identical with Iniwano.

Table 5. Order of integration and step depth from classrooms

Integration

Iniwano

library (1.22) > corridor (1.11) > outside (0.95) > open space (0.91) > court (0.85)
> specific classrooms (0.84) > corner (0.80) > playground (0.79) > classroom (0.78) > gymnasium (0.54)

Ashiwara

open space (1.06) > specific classrooms (0.98) > classroom (0.95) > roof terrace (0.92) > corridor (0.91)
= court (0.91) > corner (0.86) > gymnasium (0.85) > outside (0.85) > library (0.78) = playground (0.78)

Miyamae

court (0.99) > corridor (0.90) > specific classroom (0.82) > library (0.73) > classroom (0.71)
> open space (0.70) > outside (0.68) > playground (0.66) > gymnasium (0.65)

Step depth from classrooms

Iniwano

classroom (0) < open space (1.07) < corner (3.3) < corridor (4.57) < library (4.70) < court (6.06)
< outside (7.18) < specific classrooms (8.50) < gymnasium (10.0)

Ashiwara

classroom (0) < open space (1.63) < specific classrooms (5.26) < roof terrace (5.56) < corner (5.98)
< outside (6.97) < court (6.97) < corridor (8.43) < playground (9.42) < gymnasium (9.50) < library (10.4)

Miyamae

classroom (0) < open space (1.00) < court (6.69) < specific classrooms (7.00) < corridor (7.03)
< library (8.88) < outside (9.17) < gymnasium (10.5) < playground (10.5)

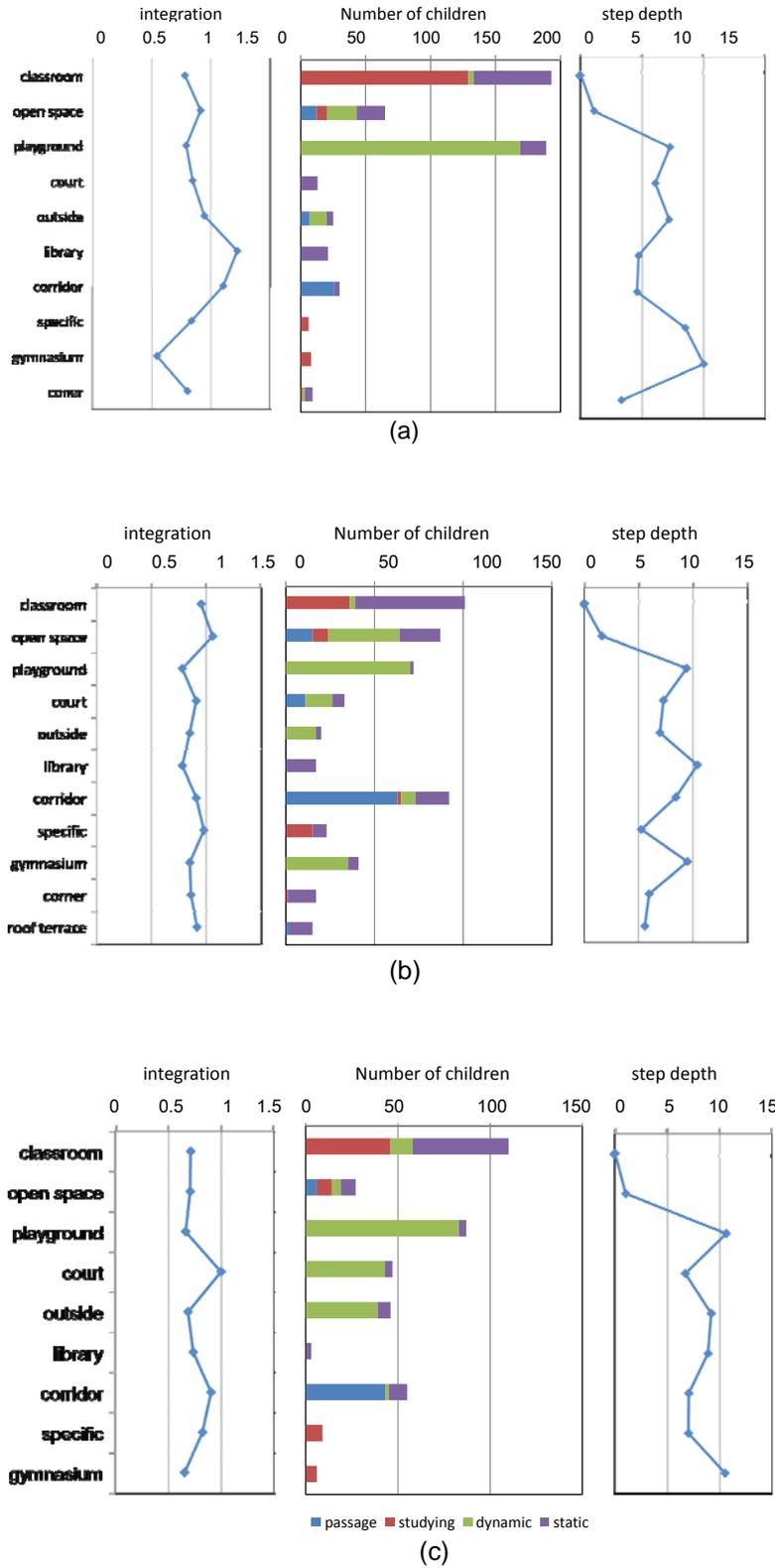


Figure 6. Relationship between spatial variables and children activities

[(a) Iniwano, (b) Ashiwara, (c) Miyamae]

In sum, the distribution of moving children tends to highly dense at high integrated space. Children use such integrated spaces that have high centrality as the routes. Studying and living activities are at segregated spaces suitable for studying and practicing as private spaces. These activities are also at such spaces with small step depth to classrooms. It is because that children use spaces around their classes for studying and living activities. However, some studying and living activities are at large step depth spaces in Iniwano and Miyamae. Although we discovered that children tend to not stay at such spaces with large step depth to classrooms, children who study or practice must go to certain spaces for example the gymnasium and specific classrooms where far distance from classrooms. Dynamic activities are everywhere and have nothing in common in integration and step depth to classrooms. Additional studies are needed to determine the tendency of dynamic activities that would have significant impacts on children activities. Static activities are mostly at such spaces with small step depth to classrooms. Static activity is the activity that can be carried out anywhere like chatting, viewing, and walking around. . Therefore, results show that children choose spaces to suit their activities for example studying for quiet and segregated space and chatting for space near their classrooms.

5. CONCLUSION

This study analyzed the distribution of the children activities in free time at three elementary schools, Iniwano, Asiwara and Miyamae. Furthermore it revealed the forms of the elementary school with the rules of Space Syntax. I compare these results and I found the following things.

- Children distribution

When children choose the place to play in their free time, they usually consider about not the space centrality but the distance between their class room and the play-space. Comparing children in the higher grades with the lower grades, I found that there is a relation between that distance and distribution of the actual play-space in children in the lower grades even though there is no connection in children in the higher grades. That is, children in the higher grades use the whole space in their school in free time but children in the lower grades use only the space around their class room.

- Depending on each activities

According the distribution chart of play-space on each activities basis, there are four types of activities. Children who go away from class room in free time (passage activity) are likely to be in the space which has strong centrality. On the other hand, children who study something or do quiet activities (studying and living activity and static activity) are apt to be in the space that has no centrality and quiet space, like a private room. Dynamic activities are less affected by the step depth to classrooms or whether the play-space has strong centrality. Static activities are found in the whole space of the school, especially in a shallow room.

These results lead some tips for creating environment to encourage children activities. The first is that it is necessary to arrange planning school settings according to grades because the distribution of the lower grades and the higher grades showed different trends. Especially, the arrangement of playground where both of children in the lower grades and the higher grades spent together is significant. Based on the result that children in the lower grades tend to use spaces around their classrooms, putting the playground closer to lower grades classrooms than higher grades classrooms is better to promote communication over grades in the playground. Second, the result showed that children tend to choose the place depending on distance

from their classrooms, therefore the space intended to promote children activities like multipurpose rooms should put near classrooms or it would be dead space seen in some schools in this time. Third point is arrangement in space considered activity type. Because children choose spaces to suit activities they try to, it is important to arrange the space layout of rooms to the task one is intended to perform.

This study searched about the children activities focused on spatial configuration in terms of the structure of space by space syntax theory. However, there are many other factors affect children activities, for example, furniture layout, dimension of space, and visibility. Further studies are needed in order to create the environment to encourage children activities.

REFERENCES

- An, E., Lee, K. 2003. Importance of Wayfinding Performance as an Evaluation Criteria for the Design of Large-Scale Shopping Center. *Journal of the City Planning Institute of Japan*, No. 564, pages 173-177
- Araya, R., et al. 2005. Analysis of Open Space in Urban Area Based on Space Syntax Theory. *Journal of the City Planning Institute of Japan*, No. 589, pages 153-160.
- Funabiki, E., et al. 2009. Comparison of the Operation Policy for Citizen Space and the Floor Planning Characteristics in City Halls Analyzed by Applying the Space Syntax Theory: Study on Ideal Way of Citizen Spaces of City Halls Part 3. *Journal of the City Planning Institute of Japan*, No. 645, pages 2357-2362
- Haq, S. 2002. Investigating the syntax line: configurational properties and cognitive correlates. *Environmental and Planning B: Planning and Design* 2003, volume 30, pages 841- 863
- Hillier, B., Hanson, J.. 1984. *The Social Logic of Space*. Cambridge: Cambridge University Press.
- Ito, S., Nagawasa, Y. 2002. Group Processes and Spatial Behavior of Children in an Elementary School Classroom and Open-Space. *Journal of the City Planning Institute of Japan*, No. 560, pages 119-126
- Kano, T., Matsumoto, A. 1993. A Study on the Architectural Planning for Museum From the View Points of the Method of Exhibition and Behavior; Study on the Layout of Exhibition and the Shape of Exhibition Room. *Journal of the City Planning Institute of Japan*, No. 454, pages 55-64
- Kigawa, T., Furukawa, M. 2005. Study on a Morphological Comparison Among Machiya by Space Syntax. *Summaries of Technical Papers of Annual meeting Architectural Institute of Japan*, pp.417-420.
- Kigawa, T., Furukawa, M. 2006. Study on a Vector in Kyoto's Modernization by Means of Space Syntax. *Journal of the City Planning Institute of Japan*, No. 40-3, pages 139-144.
- Kweon, Y. 2002. A Comparative Study on Centrality in Museum Layouts –In the Case of the Royal Museum of Scotland and Burrell Gallery. *Journal of Asian Architecture and Building Engineering* 1 (1), 205-212
- Major, M. 2001. Cloak-and-dagger theory: manifestations of the mundane in the space of eight Peter Eisenman houses. *Environmental and Planning B: Planning and Design* 2001, volume 28, pages 73-88

Rashid, M., et al. 2006. Spatial layout and face-to-face interaction in offices –a study of the mechanisms of spatial effects on face-to-face interaction. *Environmental and Planning B: Planning and Design* 2006, volume 33, pages 825-844

Takayama, K., et al. 2002. A Study on the Depth of Space in the Commercial Area - A case of Shimokitazawa. *City planning review. Special issue, Papers on city planning (37)*, 79-84

Tashiro, K., Nagawasa Y,. 1998. A Study on Architectural Planning of an Elementary School Activities and Studies. *Journal of the City Planning Institute of Japan*, No. 503, pages 109-113

Ueno, J., Harada, J. 1994. Contemporary Trend of the Architectural Planning of Elementary and Secondary Schools Which Contain the Multi-Purpose Spaces. *Journal of the City Planning Institute of Japan*, No. 458, page 71-78

Yanagisawa, K. 1991. A Study on the Territory Making of Children in Open-Space of Elementary Schools. *Journal of the City Planning Institute of Japan*, No. 424, pages 31-42