



## A Space Analysis for Comprehending the Characteristics of Eco-Friendly Exterior Space at Elementary Schools

- Focusing on Foreign Cases -

Sung, Lee-Yong\* · Jeong, Hee-Woong\*\*

\* Division of Architecture, Mokwon Univ., South Korea (leerick@mokwon.ac.kr)

\*\* Corresponding author, Dept. of Architectural Design, Dongseo Univ. South Korea (hwjeong@gdsu.dongseo.ac.kr)

### ABSTRACT

**Purpose:** The purpose of this study is to suggest a proper plan about the exterior space of elementary school in Korea through analyzing the various factors of the exterior spaces in foreign elementary school case. because the foreign cases have diversified eco-friendly certification standards on the elementary school unlike Korean cases.

**Method:** First, we review the recent eco-friendly research trends of elementary schools and the external space characteristics of elementary schools that are currently being studied through related literary surveys, And we review the korean criteria factor for eco-friendly certification, we draw the types of exterior space thorough analysis framework, using the korean criteria factor. Second, the foreign cases of the elementary school were chosen, and then some planning data such as architecture scheme, design concepts and drawings will be collected. So the data were analysed and then the characteristics of physical setting and eco-friendly certification standards will be drawn. Third, We analyzed the characteristics and factor of physical and eco-friendly of exterior space through the drawn types. **Result:** The various physical settings are appeared physical environment. when we analyzed certification factors at korean eco-friendly standards, the suggestion and guide about the eco-friendly elements than the numerical goals were treated importantly in Korea.

### KEY WORD

친환경  
초등학교  
외부공간

Eco-Friendliness  
Elementary Schools  
Exterior Space

### ACCEPTANCE INFO

Received Aug 31, 2017

Final revision received Sep 29, 2017

Accepted Oct 3, 2017

© 2017 KIEAE Journal

## 1. INTRODUCTION

### 1.1. BACKGROUND AND PURPOSE OF THIS STUDY

In these days, the interior spaces are being used increasingly rather than the exterior spaces at elementary schools due to many kinds of social trends and the ratio of various kinds of exterior spaces against the interior ones is also decreasing gradually. The reasons are because it is hard to secure the areas of the exterior spaces due to the land prices increased within cities and various types of schools are being created, such as, building-type schools, etc. Currently, the exterior spaces of elementary schools can be considered as multi-purpose spaces essential for the development of children since such exterior spaces play roles of the spaces where students can do the leisure activities as well as the regular learning activities and can be used as the play spaces for the students resulting that their sociality is enhanced and such spaces can be used as the ones where a single person can enjoy some meditation.<sup>1)</sup> Such kinds of Exterior Spaces of Elementary Schools

may play an important role as a public space of a city while many kinds of exterior spaces in a city have been diminished due to the expansion of the urban space. In addition, such exterior spaces provide citizens with various kinds of exterior spaces for staying and resting, etc. Various exterior spaces are used as a garden, a square, a playground and a vegetable garden, etc., at elementary schools.

For example, a playground is becoming a center of a community where village people play various activities by using such a playground after school. And also, the meaning of such a playground as a regional community facility is becoming more important since elementary school teachers provide the community residents with information, cultural activities and lifetime education, etc.

Like this, the exterior spaces of elementary schools are emerging as very important spaces as an alternative of a urban public exterior space essential for citizens due to the expansion of the downtown area in a city.

pISSN 2288-968X, eISSN 2288-9698  
<http://dx.doi.org/10.12813/kieae.2017.17.5.015>

1) "An Analysis of the Features of the Functions, Locations and Facilities of the

Exterior Spaces of Elementary Schools in Foreign Countries", Journal of Multimedia Services convergent with Art, Humanities and Sociology, Vol. 6, No. 12, p. 143, 2016. by Sung, Lee-yong

However, the current exterior spaces of elementary schools are composed of an urethane track and some asphalt concrete ('ASCONE') which pollute the environment with much over-detected heavy metals and thus are not eco-friendly at all.<sup>2)</sup>

Accordingly, this study is intended to suggest an appropriate planning direction of an exterior space of the elementary schools in South Korea by investigating various kinds of elements of the exterior spaces different from the ones in South Korea while, as the analysis frame, using the physical environmental elements and eco-friendly elements which basically pass through all of eco-friendliness certification examinations focusing on many foreign elementary school cases rather than the ones in South Korea under the premise that the exterior spaces of elementary schools are very important places for the behavioral development of children.

1.2. STUDY METHODOLOGY & SCOPE

As the study methods, first, the recent trend of studies on eco-friendly spaces of elementary schools which are being conducted through the reviews of the relevant literature and the features of the exterior spaces of elementary schools are examined. And the items of the Korean Eco-friendly Environment Certification Examination Criteria to be used as the analysis frame are reviewed and the types of the exterior spaces are classified. Second, the data on the architecture overview, the design concepts and various kinds of drawings, etc., of each building targeting many elementary schools in foreign countries were collected. And based on such data, the types of the exterior spaces of elementary schools are analyzed. Third, the physical environments and the eco-friendly features & elements of the exterior spaces in foreign countries based on the analyzed types.

In order to select some cases becoming the targets of this Study, the spacial scope is suggested focusing on the elementary school cases in foreign countries except for the Korean elementary schools and the time scope is suggested after collecting 8 foreign cases which were completed until now after 2000.

2. Literature Review

2.1. Review of Previous Studies

The previous studies related to eco-friendly schools are as follows. Those previous studies of this study were obtained by analyzing the academic articles related to architecture after having searched for the eco-friendly schools on the domestic articles search site, "DBPIA".

Table 1. Comparison of Previous Studies

Author	Title	Year	Theme
Cho, Dong-Woo, Yu, Soo-Hoon	A Study on the Development of Categories and Items of the Environmental Assessment Method for School Buildings	2004	Certification Criteria
Park, Joon-Seung	Planning and It's Application of Eco-friendly School	2007	Planning
Kong Sung-Hoon, and two others	The Application of Design Criteria in Environment-Friendly School Building Focused on Elementary School in Daegu City	2007	Certification Criteria
Ryu, Soo-Hoon	A Study on the Development of Category and Items for the Sustainable School Design and Assessment	2007	Sustainable School
Chung Min-Hee, Park Jin-Chul	A Study on Improvement of Indoor Environment of Schools	2007	Indoor Environment
Kim Yong-Seok, and three others	A Study on Selecting the Prerequisite Items in the Green Building Certification Criteria for Schools	2009	Certification Criteria
Park, Jae-Hong, John, Che-Hui	A Study on the POE(Post Occupancy Evaluation) about Environment-friendly Design Factors in Educational Facilities - Focusing on School Buildings in Gimhae	2009	POE
Kang, Eun-Ju	Condition Analysis of Biotope Area Rate in Certified Environmental-Friendly Schools	2009	Biotope Area Rate
Jung Ji-Na, and three others	A Study on Comparison and Analysis of the Obtained Scores in the Assessed Green Schools	2009	Certification Criteria
Ko, Dong-Hwan	A Study on BIM-based Sustainable Design Process using Building Performances and Energy Efficiency Evaluation	2010	BIM
Lee Tae-Moon	A Study on the Design Analysis of BTL Project in Education Facilities	2010	Design Analysis
Young-Cheol Kwon, Chang-Ho Choi	A Study on the Ecology of Education Facilities in Green Building Certification Criteria	2010	Certification Criteria
Yoo-Jin Shin, and three others	A Study on the Indoor Environment Condition in Green Building Certification Criteria	2010	Certification Criteria
Jung Ji-Na, and three others	A Study on the Improvement of Korea Green Building Certification System by the Maintenance Survey Result of Certified School Facilities	2010	Certification Criteria
Lee, Ji-Young, Lee, Kyung-Sun	A Study on Examples of Eco-Friendly School Design	2011	Case study
Yang, Won-Seok, Chu, Beom	A Study on the Comparative Analysis of the Green Building Certification Criteria for Schools in remodeling	2011	Certification Criteria
Wang, Jeong-Joon, and two others	A Comparative study on the ecological environment of Green Building Certified Schools	2011	ecological environment
Chung, Yu-Gun, 2 and two others	A Case Study on the Middle Schools with a Environment-Friendly Certification in Chungbuk Area	2011	Certification Criteria
Sim, Jae Deok, Kim,	The Improvement Direction of Green Building Certification Criteria in Korea by the Case Studies of Educational Facilities	2013	Certification Criteria

2) Incheon ILBO, Playgrounds taking off Urethane Costumes, August 4, 2017 (<http://www.incheonilbo.com/?mod=news&act=articleView&idno=774384>)

Chang Sung			
Kim, Chang-Sung	The Analysis on the Assessment Categories of Korea Green Building Certification Criteria by the Case Studies of Educational Facilities	2013	Certification Criteria
Cho, Min-Kwan	Domestic Research Trend for Sustainable School	2013	Case study
Moon, Sun-Ki, and two others	A Study on Evaluation Indicator Analysis of the Green Building Certification	2013	POE
Kim Yong-Jae, Kim Jun-Tae	A Study on the Integrated Design Process for Green Remodeling of School Buildings	2014	Design Process
Park, Eui-Chang, Kim, Gi Soo	A Comparative Study on Eco-friendly Architectural Technique Elements Applied to Educational Facilities in Korea and Japan	2017	Eco-friendly Technique Elements

The results from an analysis of the previous studies on eco-friendly schools are summarized as follows.

First, as the results from an analysis of the years when the previous studies were conducted, there were the most frequent studies from 2007 to 2013, but there were few studies on eco-friendly schools before 2007 and only one (1) study was conducted in 2014 and 2017 respectively after 2013. Thus, it is concluded that the studies on eco-friendly schools are rarely conducted recently.

Second, the most frequently studied themes were the ones related to the eco-friendliness certification in the previous studies taking 41.7% of share of the total themes and the evaluations after residing and case studies take 8.3% respectively. And there were various kinds of studies dealing with planning, sustainable schools, interior environment, biotope area ratio and design analysis, etc., which are dealt with as one theme in one study respectively.

Third, 91.7% of the spaces dealt with in the previous studies of the total number are the contents related to school structures and only 2 studies were on the interior spaces of schools. It was found that there were no studies on eco-friendly environments of the exterior spaces of schools.

Thus, as the results from an analysis of the previous studies, it was found that this study has a difference from those previous ones since this study is related to the schools that have not recently studied regarding to the eco-friendly environments, but is not related to the eco-friendly environment certification that has been dealt with as one theme in the most number of studies. In addition, it is considered that this study has its own value in the aspect that this examined the eco0-friendly exterior spaces, but not interior ones in the aspect of the space type studied.

## 2.2. Features of Exterior Spaces of Elementary Schools

The biggest features of the exterior spaces of elementary schools are as follows. First, it can be said that such spaces play a role as a

public space in a city. As a city is being developed, the exterior spaces of each building are being diminished. And under the situation that a city has mainly many ultra-dense high-rise residential buildings due to the features of the Korean housing environment, the exterior spaces are being much more diminished.

Therefore, the roles of the exterior spaces of elementary schools are becoming bigger and bigger as various kinds of public spaces which can be used by citizens. As an example, a playground as mentioned above is used for the leisure and rest of citizens and community members while being opened on weekend while the students do not use it.

Second, during the period when many elementary schools which used to be designed in accordance with the standard designs in the past are becoming smaller and smaller as time goes by, the playground-centered exterior spaces of an elementary school and the area of the unit exterior area per capita has been excessively reduced. And also, the classification of spaces into the dynamic spaces (play yards and playgrounds, etc) and the static spaces (gardens and courtyards, etc) in the aspect of the functionality and the qualitative changes of the exterior spaces, such as, piloti, courtyard and rooftop, etc.

Third, young students spend very much time at elementary schools as the spaces which are used by young students and where the students learn various styles of social lives as well as studying. Therefore, the Korean government has prepared for many kinds of appropriate standards on the current eco-friendly environment levels and has made the acquisition of a certain level of eco-friendly environment certification for each area compulsory. And it can be said that the biggest party among the eco-friendly environment areas that a school must have is the exterior educational environment. Then, it is assumed that the educational effects related to eco-friendly environments shall be made directly to students.<sup>3)</sup> Therefore, studies on the eco-friendly exterior spaces will play a very important role in the aspect mentioned above.

## 2.3. Criteria on Exterior Spaces subject to the Examination of Eco-Friendly Environment Certification

The eco-friendly elements based on the School Facilities Certification Examination Standards are broadly divided into 7 categories. 1. Land Use and Transportation, 2. Energy & Environment Pollution, 3. Materials & Resources, 4. Water Circulation Management, 5. Maintenance, 6. Ecological Environment and 7. Interior Environment. Among those categories mentioned above, this Study deals with only Ecological

3) Mr. Wang, Jung-joon, Mr. Sung, Soon-taek & Mr. Kim, Byeong-sun, "A Comparative Study on Ecological Environments of Elementary and Middle Schools certified as eco-friendly structures ", Journal of the Korea Institute of Ecological Architecture and Environment, Vol. 11, No. 2, p.97, 2011.

Environment. The contents of the exterior spaces of schools in that aspect are composed of as follows. 6.1. Creation of Some Greenland within a Parcel of Land (6.1.1. Creation of Connected Greenland Axis & 6.1.2. Natural Ground Greenland Rate), 6.2. Securing the Ecological Functions of Exterior Spaces and Building Envelopes (6.2.1. Ecological Area Rate), 6.3. Creation of the Habitats for Living Creatures (6.3.1. Creation of Biotope & 6.3.2. Creation of Ecological Learning Center), 6.4. Utilization of Natural Resources (6.4.1. Recycling Rate of Top Soil).<sup>4)</sup> In this study, the eco-friendly environment certification area of our country shall be compared with foreign cases as an item which is analyzed in connection with the types of the exterior spaces of elementary schools.

### 2.4. Types of Exterior Spaces

Regarding to general exterior spaces, Mr. Asahara Yoshinobu considered 3 elements restricting architectural spaces as floor, wall and ceiling in his book named 'A Sequel to the Esthetics of Exterior Spaces' and he argued that such elements are used for distinguishing the interior spaces and the exterior ones and it is a method that the order of spaces going from a boundary toward the inside is centripetally maintained.<sup>5)</sup> That is, a space without even one element among 3, it can be said as an exterior space.

In addition, an exterior space as a quasi-private space has a feature as a mediating space together with a public space and can show its compositive characteristics.

The functions of exterior spaces can be examined by being divided into two categories, that is, one for walking & staying and the other for resting & playing. A pedestrian space as a dynamic space means a space whose main purpose is to make people move on an avenue or a street. A static space means one having a wide area as an open space which is not an avenue or a street as a space for staying, resting and playing except for walking, such as, a square and a park, etc.

Table 2. Types of Exterior Spaces

Function of Exterior Space	
Static Space	Garden, Park, Square, Public Open Area, Landscape in building site, Green area and rest areas, Atrium
Dynamic Space	Play Ground, Play Field, Pilotis, Amusement park for kids Sports facilities, Stadium, Waterfronts

## 3. An Analysis of Types of Exterior Spaces of Elementary Schools

### 3.1. Functional Classification of Exterior Spaces of Elementary Schools

4) <http://www.kisee.re.kr>, Korea Institute of Sustainable Design & Education Environment, School Facilities Certification Examination Standards  
 5) Mr. Asahara Yoshinobu, A Sequel to the Esthetics of Exterior Spaces, Kimundang, 1990, p.9

The target of this Study is elementary schools and the exterior spaces of elementary schools are analyzed on the basis of the cases analyzed in this study even though the exterior spaces reviewed earlier have their theoretical meanings in the aspect of the urban functions. In addition, the exterior spaces of elementary schools unlike those of a city are very small in the aspect of the sizes and they are easier to be classified functionally since the behaviors and actions of active students are not various.

The open spaces of elementary schools are divided into ones for staying, resting and playing in the aspect of functions. And the open spaces can be analyzed by dividing into the static ones and the dynamic ones depending on the specific functions. For the purpose of analyzing, the static open spaces are functionally classified into gardens, parks and courtyards, etc., where some static activities of people, such as, staying and resting, etc., are mainly conducted and the dynamic ones are analyzed into the ones as play yards, playgrounds, swimming pools and pilotis, etc.

The types of exterior spaces can be classified as follows.

Table 3. Function of Exterior space based on Elementary school

Function of Exterior Space				
Static Space	Garden	Park	Courtyard	Terrace
Dynamic Space	Play Ground	Play Field	Pool	Pilotis

### 3.2. Classification of Exterior Spaces of Elementary Schools depending on the Locations of Cross Sections

Spaces in architecture is composed of 3 dimensions. That is, such spaces are 3-dimensional rather than flat and such 3-D spaces are divided into 3 kinds of spaces, that is, air as a space above the ground, the ground and the underground space below the ground. In architecture, the exterior space is composed of 3 kinds of spaces like the interior ones. First, the air space is surrounded by walls and floors only as the upper space and is defined as an exterior space open to the public. Taking into consideration of the systems and laws & regulations, the minimum ceiling height is defined at 2.4m and the height above the ground is restricted to 4.95m. A ground space means the ground surface and also refers to the 1<sup>st</sup> Floor of a building except for an air space and an underground space as ones at the same level as that of the ground surface. Regarding to an air space, in a study on the systems and laws & regulations on air spaces, the minimum ceiling height is defined at 2.4m and means a space above the ground surface that exists below the space whose the height from the ground is restricted to 4.95m.

Finally, an underground space is defined as a certain scale of space resource which is created naturally or artificially below the ground surface within the scope available for some rational

purposes by the American Underground Space Association.<sup>6)</sup> As another definition, it means “a space which is created by excavating soils or rocks horizontally or vertically below the ground surface”.<sup>7)</sup>

Therefore, while analyzing some exterior spaces, various kinds of 3-D spaces as well as ones above the ground must be analyzed. In the modern era, many exterior spaces are planned in air or under the ground as well as on the ground. Owing to such a trend, the exterior spaces of an elementary school are planned aggressively as air spaces and underground ones in order to create various kinds of exterior spaces within a narrow land.

Table 4. Types of Exterior space Locations



### 3.3. Classification of Exterior Spaces of Elementary Schools depending on Eco-friendly Environment Certification

If each element is applied to the classification by comparing with the types of exterior spaces related to the Eco-Friendly Environment Certification Examination specified in Article 3, Chapter 2 above, the classification is as follows.

In 6.1. ‘Creation of Green Space within a parcel of land’, 6.1.1 ‘Creation of Connected Green Belt Axis’ is intended to analyze whether any green land which is connected to a space inside or outside a school exists or not. In 6.1.2. ‘Green Area Ratio on Natural Ground’, it is analyzed which types of exterior spaces are located on natural ground, such as, playgrounds, amusement parks and squares, etc., by analyzing the plans for creating natural grounds rather than the relevant green area ratio itself. Regarding to 6.2. ‘Securing the Ecological Functions of Exterior Spaces and Building Envelopes’, 6.2.1 ‘Ecological Area Rate’ is intended to analyze the spaces which are not ecological by checking whether any ecological areas exist or not in all exterior spaces of the relevant cases. In 6.3.1 ‘Creation of Biotope’ of 6.3. ‘Creation of Habitats for Living Creatures’, the types of relevant gardens, water spaces and ecological ponds, etc., are analyzed. In 6.3.2 ‘Creation of Ecological Learning Center’, it is analyzed whether any (6.3.2 생태학습원 조성은 생태학습원 시설의 유무를 분석한다.) Finally, 6.4.1 ‘Recycling Rate of Topsoil’ of 6.4. ‘Utilization of

6) Mr. Lee, Gang-joo & Mr. Seo, Chung-won, A Study on Setting the Construction Guidelines of Underground Spaces, Journal of the Architectural Institute of Korea, Planning & Design, 22 Vol., 4 Issue (Whole Vol. NO. 210), Apr. 2006, p.48

7) Mr. Sun, Yong, Cities & Underground Spaces, Urban Problems, Aug. 1985, p.9

Natural Resources’ shall be excluded since it is a part which cannot be surveyed in this study. A comparative analysis of various kinds of exterior spaces that are shown in the elementary schools in foreign countries is conducted through the foreign case study regarding to the Eco-friendly Environment Examination Criteria as shown in Table 5.

Table 5. Analysis Elements of Eco-Friendly Certification standards









Division	Details	Analysis Elements
Creating a green space in the site	Composition of green belt axis	Exterior space adjacent to the site
	Natural green area ratio	Play Field, Play Ground, Square, etc
Securing ecological functions of Exterior space and building envelope	Ecological area rate	All Exterior space
Creating a living habitat spacer	Creating a Biotope	Garden, Water space, Ecological pond
	Creating an eco-learning center	Creating an eco-learning center
Utilizing natural resources	Topsoil recycling rate	None

## 4. A Case Analysis of Exterior Spaces of Elementary Schools

### 4.1. General Overview of Cases

In this Study, 8 cases of Elementary Schools in Foreign Countries were surveyed.

Table 5. Analysis Elements of Eco-Friendly Environment Certification

Division	Imagine	Location	area
Multi-Purpose Education Centre		France(Paris)	5,600m <sup>2</sup>
Primary School For Sciences And Biodiversity		France(Boulogne)	6,766m <sup>2</sup>
Expansion of the school		Netherlands(Basse )	3,900m <sup>2</sup>
Burr Street Elementary School		USA(Connecticut)	6,503m <sup>2</sup>
Manassas Park Elementary School		USA(Connecticut)	13,000m <sup>2</sup>
Kiowa County Schools		USA(Greensburg)	11,612m <sup>2</sup>
Colegio Antonio Derka		Colombia (Antioquia)	13,006m <sup>2</sup>
Rakafot Elementary School		Israel(Kiryat Bialik)	2,700 m <sup>2</sup>

## 4.2. Case Analysis

### 4.2.1 Multi-Purpose Education Center

A Multi-purpose Education Center is a kind of school where an elementary school and a kindergarten exist together as an educational center having multi-purposes as can be seen from its name itself.

A nature-friendly school is planned by creating a play yard (a basketball court) and a playground in the courtyard in the middle of the school, by creating a rooftop garden and a rooftop deck and by finishing with lawn. In addition, a space for the regional community is created by making the village people access easily through a passage which is established in the middle area of the school.

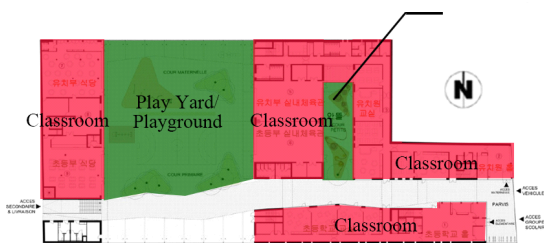


Fig. 1. Plan for Multi-Purpose Education Center

### 4.2.2 Primary School For Sciences And Biodiversity

A Primary School For Sciences and Biodiversity is a kind of elementary school specializing in bioscience. This kind of school secures a large area of green space in the building itself to be appropriate for the theme and also has some kinds of organic types of buildings. The first floor is created as a courtyard type having an exterior playground. On the second floor, a play yard is planned on another layer of deck. The fifth floor is created as a rooftop garden in order to create an eco-friendly school.

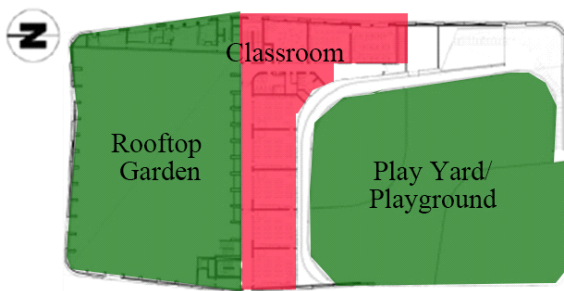


Fig. 2. Primary School For Sciences And Biodiversity Plan

### 4.2.3 Expansion of the School

The Expansion of the School is located in Wassenaar, the Netherlands and this school is a rural school where a primary school and a kindergarten are included after establishing the school in connection with the regional handball club and establishing the kindergarten by remodelling the existing farmland building. The

handball club for the regional community makes the students get interested in the physical activities and does the community residents get interested in the school. Such two spaces are connected to each other through a bridge and there exists a big space under the bridge.

Based on the eco-friendly environment plan, this school generates solar energy, uses LED apparatus and uses heavy water in order to create energy by using nature. In addition, owing to the recognition of the sustainable solutions of some problems, the building was planned in order for the surrounding environment to be harmonized with the landscape.

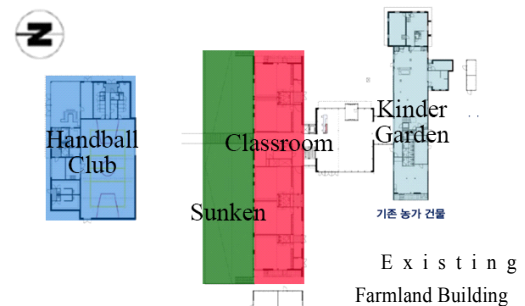


Fig. 3. Expansion of the school Plan

### 4.2.4 Burr Street Elementary School

This Burr Street Elementary School creates the outdoor learning space in connection with nature since it is located in a natural region in the suburb. The interior space inside the outer walls of a linear building has a non-linear shape like an amoeba and it is possible to create free traffic line by using the circular paths. A big courtyard is located in the middle and is used as a playground. And the courtyard is planned to attract some external nature into the entrance gate.

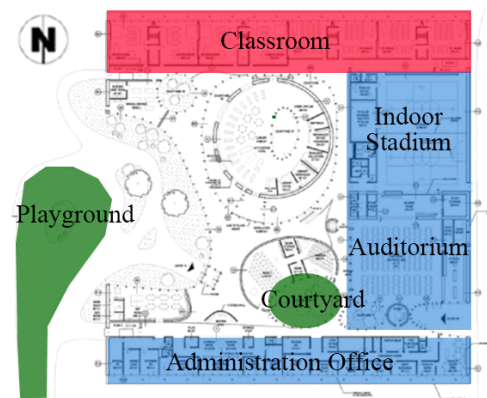


Fig. 4. Burr Street Elementary School Plan

### 4.2.5 Manassas Park Elementary School

The Manassas Park Elementary School has 2 courtyards between the buildings. When a person enters into one, it is led in order to be connected naturally to a road between the surrounding residential area. So, it is possible to use it as a bicycle road or a trail.

In addition, the circular ecological garden is connected to a streamlet in order to be used as a space for disposing the rain outflow and to be utilized as an outdoor classroom or stage usually. The building system introduces some kinds of eco-friendly elements since it has a geothermal heating pump, a light-shelf, a natural convection-type system and a rainwater utilization system.

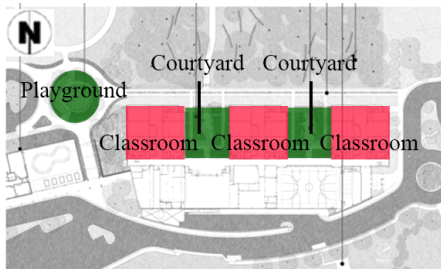


Fig. 5. Manassas Park Elementary School Plan

#### 4.2.6 Kiowa County School

Kiowa County School is a school which was created as a community facility for playing a hub role of the rural community and also as a meeting place for the village people after having established the school in the middle of the city that had been destroyed by a tornado. This school is composed of a kindergarten, a primary school, a high school and a gymnasium. The courtyard between the high school and the primary school is restored as a wetland and is also playing a role as a trail. In addition, a rooftop garden is created on the roof of the primary school. As the eco-friendly elements, this school enhanced the resistance against the invaded moisture by using the HVAC system and reduced the energy load and it is designed to take natural lights and ventilation aggressively.

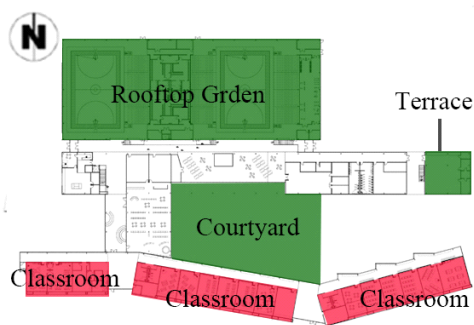


Fig. 6. Kiowa County Schools Plan

#### 4.2.7 Colegio Antonio Derka

Colegio Antonio Derka is a primary school located in a slum, Antioquia Province, Columbia. The biggest feature is that this school forms various levels of exterior spaces since it is located on a hill with big differences between levels. These exterior spaces play a role for the improvement of the surrounding environment,

provision of resting spaces and the smooth access by the community residents. Therefore, the traffic lines of students and residents are separated. The main access to the surrounding area is made from the rooftop and thus the rooftop garden is created.

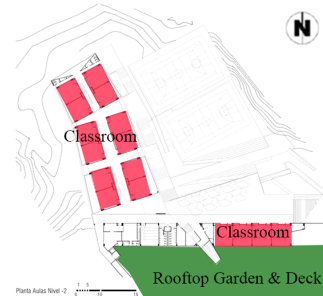


Fig. 7. Colegio Antonio Derka Plan

#### 4.2.8 Rakafot Elementary School

Rakafot Elementary School is a school which was established by planning the landscape mainly as an elementary school located in Israel. A footpath is made in the center of the school and the school buildings are arranged along the footpath and then many exterior spaces are planned for the spaces between the buildings. In such exterior spaces, some spaces where students can rest freely, such as, various kinds of playground, ecological ponds (winter ponds) and resting gardens, etc., are created. The school is planned in order for the students to take many kinds of eco-friendly lessons based on the ecological environment.

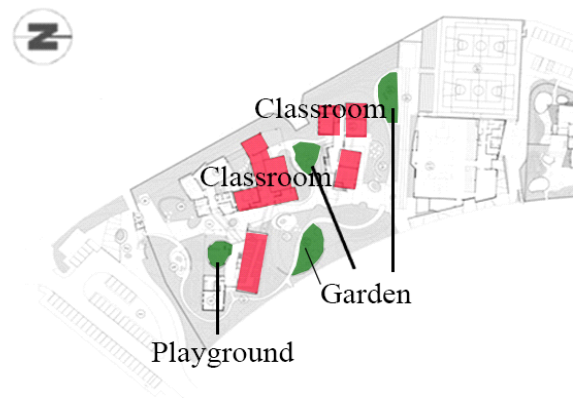


Fig. 8. Rakafot Elementary School Plan

#### 4.3. Features of Eco-Friendly Exterior Spaces in 8 Cases

If the features of eco-friendly exterior spaces in 8 cases of elementary schools in foreign countries are compared, the results are shown like in Table 6.

In this study, exterior spaces are analyzed by dividing the physical analysis and the method specified in the Eco-Friendly Environment Certification Examination Criteria.

Table 6. Overall Analysis of case

School Name	Space Name	Physical Elements					Eco-Friendly Elements					
		Function		Location			Creating a green space in the site		Securing ecological functions of Exterior space and building envelope	Creating a living habitat spacer		
		Static Space	Dynamic Space	Space above Ground	Ground	Under Ground	Composition of green belt axis	Natural green area ratio	Ecological area rate	Creating a Biotope	Creating an eco-learning center	
Multi-Purpose Education Centre	Roof Garden	○	×	○	×	×	×	×	○	×	×	
	Roof Deck	○	×	×	○	×	×	×	×	×	×	
	Play Field	×	○	×	○	×	×	○	×	×	×	
	Play Ground	×	○	×	○	×	×	○	×	×	×	
Primary School For Sciences And Biodiversity	Pilotis	○	×	×	○	×	×	○	×	×	×	
	Roof Garden	○	×	○	×	×	×	×	○	○	×	
	Roof Deck	○	×	○	×	×	○	×	○	×	×	
	Play Field	×	○	○	×	×	×	○	×	×	×	
	Play Ground	×	○	×	○	×	×	○	×	×	×	
Expansion of the school	Courtyard	×	○	×	○	×	×	○	×	×	×	
	Play Ground	×	○	×	○	×	○	○	○	×	×	
	Garden	×	○	×	○	×	○	○	○	×	×	
Burr Street Elementary School	Sunken	○	×	×	×	○	×	×	○	×	×	
	Courtyard	○	×	×	○	×	○	○	×	×	×	
Manassas Park Elementary School	Play Ground	×	○	×	○	×	×	○	×	×	×	
	Courtyard	○	×	×	○	×	×	○	○	○	○	
Kiowa County Schools	Garden	○	×	×	○	×	○	○	○	○	×	
	Roof Garden	○	×	○	×	×	×	×	○	○	×	
Colegio Antonio Derka	Courtyard	○	×	×	○	×	×	○	○	○	×	
	Play Ground	×	○	×	○	×	○	○	×	×	×	
	Terrace	○	×	○	×	×	×	×	×	×	×	
	Garden	○	×	×	○	×	○	○	○	×	×	
	Roof Deck	×	○	○	×	×	×	×	×	×	×	
Rakafot Elementary School	Roof Garden	○	×	○	×	×	×	×	○	×	×	
	Play Field	×	○	×	○	×	○	○	○	×	×	
	Pilotis	○	×	×	○	×	○	○	×	×	×	
	Courtyard	○	×	×	○	×	○	○	×	×	×	
Elementary School	Courtyard	○	×	×	○	×	○	○	○	×	×	
	Garden I	○	×	×	○	×	○	○	○	○	○	
	Garden II	○	×	×	○	×	○	○	○	×	×	
Elementary School	Play Ground	×	○	×	○	×	○	○	○	×	×	

In a physical environment, various kinds of spaces appear. As a static space, gardens are divided into rooftop gardens and ground ones, etc. And also, a rooftop deck is positively used. Moreover, a courtyard is a space which is shown in almost all cases. So, various small spaces are planned inside such a space.

Unlike our country, a playground as a dynamic space is not essential. And small scale of sports facilities, such as, an indoor stadium and a basketball stadium were surveyed and it is shown that there are many play yards.

If the elements related to eco-friendly certification authorities are analyzed, it is shown that a plan for eco-friendly elements gets more important than the quantitative aspect as shown in some standards of our country. Especially, as the results from an analysis, it is assumed that the most important element is the part having created the green land axis in the section for creating green land within the ground.

That is, an important element is to create green zones and natural environment that are harmonized in the vicinity of the school rather than having many green zones in the exterior space.

## 5. CONCLUSION

As the results from a comparison of the physical environment elements and the elements of eco-friendly environment certification criteria in the exterior spaces of foreign countries, the following conclusion is made.

Usually, the static spaces and dynamic ones in the physical environment are planned as a similar number of space. In addition, regarding to the problems to 3-D spaces, they do not create a rooftop garden as an essential space unlike our country, but plan properly depending on each topography and the usage of a building. Especially, there are many cases that a rooftop deck is used in foreign countries.

Moreover, since only one case regarding to underground spaces exists due to the characteristics of a school, the natural sunshine and lighting, etc., are considered as important parts for the spaces where children live.

Regarding to the Eco-Friendly Environment Certification Examination Criteria, the following results are drawn.



First, even though a green belt axis related to the creation of a green zone space within a parcel of ground generally takes the green zone axis connected from the ground space aggressively, a green belt axis is connected by using a rooftop garden or a rooftop deck depending on each level difference.

A playground and a play yard as dynamic spaces on natural ground have not a high green area ratio and, especially, a play yard which is not an artificial one like in South Korea is a natural rubber one without creating an artificial green area. In case of a garden, in the western countries, a partial green area is preferred to the whole green area due to the different views on a garden from the oriental perspective.

Second, regarding to the ecological area rate showing the securing of ecological functions of an external space and a building envelope, it is found that the most frequently created space among the exterior spaces of elementary schools is a garden. As a peculiar point, in case of rooftop decks, those areas are planned as the whole green area, so it is found that such areas are created by considering the ecological area ratio on a walking space unlike the plans for creating the green area on the rooftop gardens in our country.

Finally, regarding to the creation of habitats for living creatures, there are some cases that a biotope is installed on a rooftop garden or a courtyard. The common point of such cases is shown in a big area of space, but there are few cases that an ecological learning center is created.

Taking the conclusive view through this study, even though it was first thought that there might be much more eco-friendly elements in foreign cases, but only the minimum green area is created on an exterior space while considering the characteristics of a parcel of land and the location of a school rather than making a plan for common eco-friendly environment as an absolute standard. That is, an exterior space is composed of some eco-friendly elements appropriate for the functions of the space rather than green area. In addition, it was found that it is more focused on some eco-friendly energy and equipment for the whole system.

## Reference

- [1] 성이용 “국외 초등학교 외부 공간의 기능, 위치, 시설의 특성 분석” 예술인문사회융합 멀티미디어 논문지 Vol. 6, No. 12, 2016.  
Mr. Sung, Lee-yong, “An Analysis of Functions & Locations of External Spaces and Features of Facilities of Foreign Elementary Schools”, Journal of Multimedia Services convergent with Art, Humanities and Sociology, Vol. 6, No. 12, 2016.
- [2] 왕경준, 성순택, 김병선, “친환경건축물 인증 초·중등학교의 생태환경에 관한 비교연구”, 한국생태환경건축학회 논문집, Vol. 11, No. //  
Mr. Wang, Jeong-joon, Mr. Seong, Soon-taek, Mr. Kim, Byung-seon, “A Comparative Study on the Ecological Environment of Green Building Certified Schools” The International Journal of The Korea Institute of Ecological Architecture and Environment, Korea, Vol.11, No. 2, 2011
- [3] <http://www.kisee.re.kr>, (사) 한국 교육·녹색환경연구원, 학교시설 인증 심사기준 // the Korea Institute of Sustainable Design and Educational Environment, School Facilities Certification Examination Criteria
- [4] 아사하라 요시노부, 속 외부공간의 미학, 기문당, 1990. // MR. Ashihara Yoshinobu, Zoku Cityscape Mino aesthetics, Kimundang, 1990.
- [5] 안진이 역, “헤르만 헤르츠버거의 건축수업”, 1판, 효형출판, 서울, 2009. // Translated by Mr. Ahn, Jin-ye, “Architectural Class by Herman Hertzberger”, Edition1, Hyohyeong Publishing, Seoul, 2009
- [6] 이강주, 서충원, 지하공간 건축가이드라인 설정에 관한 연구, 대한건축학회논문집 계획계 22권 4호, 2008. // Mr. Lee, Gang-joo & Mr. Seo, Chung-won, A Study on Setting the Construction Guidelines of Underground Spaces, Journal of the Architectural Institute of Korea, Planning & Design, 22 Vol., 4Issue, 2008
- [7] 이강주, 서충원, 지하공간 건축가이드라인 설정에 관한 연구, 대한건축학회논문집 계획계 22권 4호, 2008. // (Sun Yong, urban and underground, urban problem, 1985.)
- [8] <http://www.archdaily.com/777850/multi-purpose-education-centre-atelier-philea>
- [9] <http://blog.naver.com/imbc21c/220136123598>
- [10] <http://www.archdaily.com/624786/rakafot-school-s-grounds-landscape-architects>
- [11] <http://www.vmdo.com/>
- [12] <http://www.bnim.com/project/kiowa-county-schools>