community walking environments - from the perspective of physical activity
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# THE RELATIONSHIP BETWEEN NATURAL RESOURCES AND CHILDREN'S INTERACTION WITH NATURE IN EXPERIMENTAL PRIMARY SCHOOLS: A STUDY ON ENVIRONMENTAL SETTINGS AND CURRICULUM IN TAIWAN'S EXPERIMENTAL PRIMARY SCHOOLS (1093)

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**Abstract.** The intellectual development of children has always been a crucial part of education. However, traditional education in Taiwan often leads to a limited understanding of the local community and a lack of interaction with nature and the community, thus impacting their developmental rights. In recent years, the Ministry of Education has promoted the "Outdoor Education Program" to encourage schools to lead students out of the campus and engage with nature.

Unfortunately, COVID-19 has hindered the implementation of this program. Experimental schools, on the other hand, have integrated natural resources into their spaces early on. Therefore, through researching how these schools utilize natural resources to support the curriculum, we hope to evaluate the assistance and limitations provided by different natural environmental experiences while considering the rights of children's development. This study aims to provide a framework for adjusting campus and surrounding environmental planning within the context of traditional education in Taiwan.

**Keywords:** children, natural resources, interaction with nature, experimental primary school, COVID-19 epidemic.

## 1. Introduction

### 1.1 Research Background and Motivation

The expansion of urban areas has resulted in the majority of children growing up in urban environments with fewer opportunities for contact with nature. Richard Louv (2008) mentions that the diminishing presence of natural environments and the convenience of technology have led to a decrease in outdoor attractiveness, giving rise to the concept of "nature deficit disorder." The United Nations' Convention on the Rights of the Child, established in 1990, unanimously recognizes that the goal of children's

education is to "enable the child's personality, talents, and mental and physical abilities to develop to their fullest potential." The phenomenon of "nature deficit disorder" in the modern environment appears to contradict the educational goals outlined in the Convention on the Rights of the Child.

The impact of natural environments on child development is receiving increasing attention, and numerous studies have explored the relationship between various natural scales and different aspects of children's development (Arola et al., 2023; Hong et al., 2021; Zare Sakhvidi et al., 2022). Louv (2008) points out that in addition to its influence on physical and psychological aspects, interacting with nature not only enhances creativity but also has therapeutic effects on ADHD. However, traditional education in Taiwan itself limits children's opportunities to engage with nature and lacks interaction with the local community, thereby affecting their rights to development. The Ministry of Education's National Education Direction announced in 2022 encourages educational innovation and experimentation, implements diverse outdoor education, and promotes mountain and marine education, aiming to shift students' learning from the classroom to the real world. However, compared to the educational focus of traditional schools, experimental schools integrate natural resources into their spaces earlier and utilize the natural environment to support their curriculum. The outbreak of Covid-19 in 2019 had various impacts globally, and Taiwan faced significant restrictions on school activities from May 2021 to July 2022, hindering the implementation of diverse outdoor education programs and making it even more challenging for children to have opportunities to engage with nature.

### 1.2 Research Objectives

This study focuses on elementary schools, which represent the longest period of compulsory education in the national education system, and selects school campuses where social status backgrounds are relatively equal and fair. By examining how experimental schools utilize natural resources to support their curriculum, the study aims to analyze and summarize the relationship between different categories of natural places and the level of interaction in children's environmental cognitive development. Through this analysis, the study aims to evaluate the assistance and limitations provided by different nature-based experiences in curriculum design and planning, which can serve as a framework for future discussions on adjusting campus and surrounding environmental planning in traditional education. In summary, the research objectives of this study include the following three points:

a) Analyzing the environmental composition of experimental schools that highly incorporate natural resources into their curriculum.

b) Understanding the differences in how schools incorporate natural resources into their curriculum and adapt during the pandemic.

c) Verifying the extent to which children interact with nature in the curriculum.

### 1.3 Research Process

Based on the context of the research background and motivation, the research process and objectives are illustrated in the following diagram.

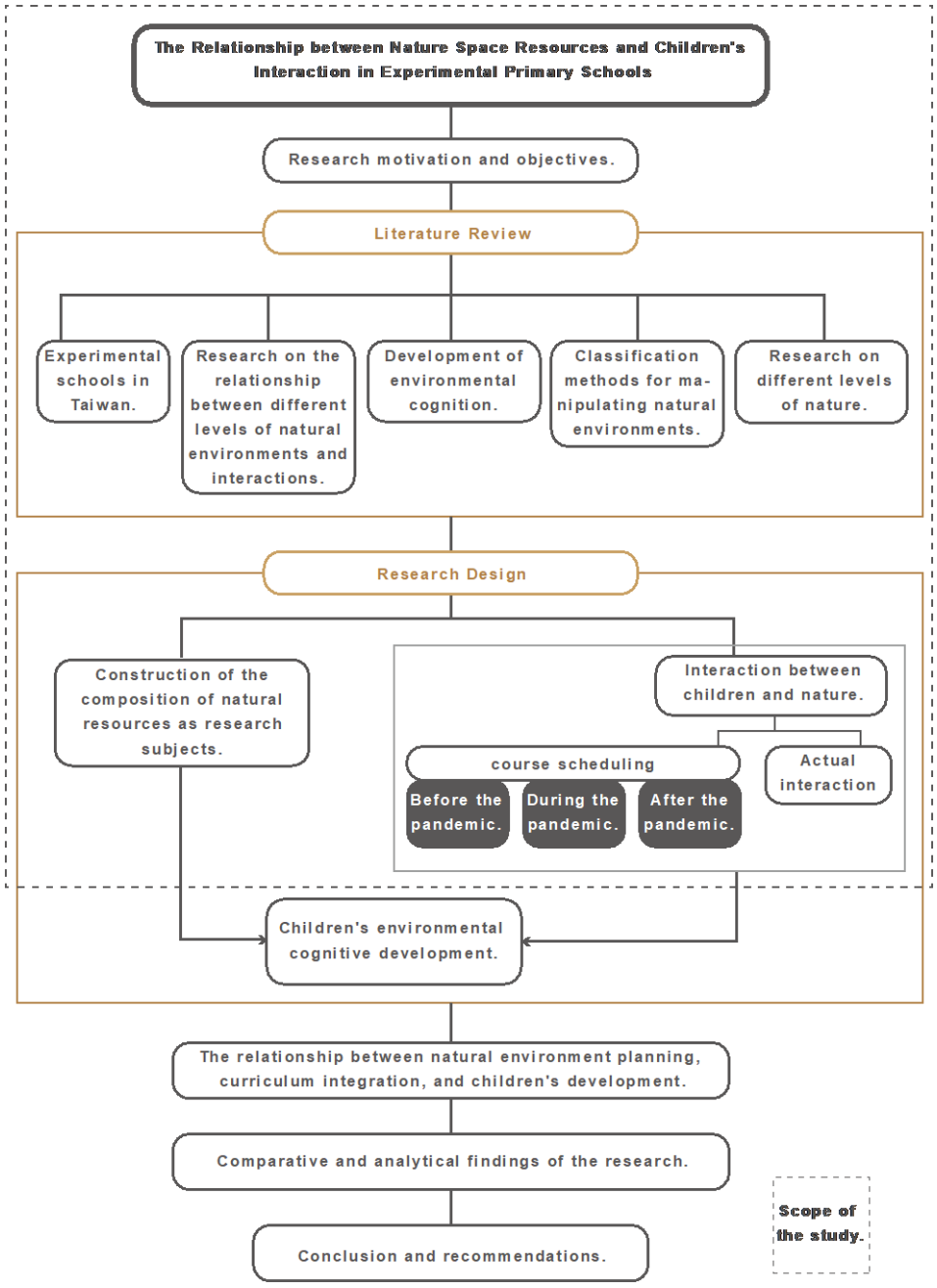


Figure 62 Research Flowchart

## 1.4 Research Scope

This section provides explanations and definitions for various research scopes in this study:

*1.4.1 Natural resources*

The term "natural resources" in this study is based on the Land Cover Classification System (LCCS) developed by the Food and Agriculture Organization of the United Nations (FAO). This system categorizes natural areas into primarily vegetated and primarily non-vegetated areas.

*1.4.2 Environmental cognition*

The definition of "environmental cognition" in this study is based on Gifford et al.'s (2011) definition, which refers to the process of seeking clues and identifying important elements and features of a scene in a real environment. It involves the perception and exploration of the environment, leading to an understanding of the environment.

*1.4.3 Nature experiences*

Based on Kellert's (2002) categorization, nature experiences can be classified as direct, indirect, or symbolic. In this study, "nature experiences" are defined as direct experiences, while experiences during the pandemic include symbolic experiences.

*1.4.4 Interaction with nature*

The term " interaction with nature " in this study is based on the concept of nature experiences proposed by Cornell, a naturalist educator. It refers to the interaction between individuals and nature using the five senses.

*1.4.5 School curriculum*

The "school curriculum" defined in this study refers to the curriculum that takes place in a natural environment, with the natural environment serving as an important teaching resource. The curriculum design focuses on engaging students in activities within the natural environment.

*1.4.6 Experimental schools*

Based on the classification of experimental schools by Common Wealth Magazine (2022), the definition of "experimental schools" in this study includes schools that embrace ecological concepts and extensively incorporate natural resources into their curriculum.

## 2. Literature Review

### 2.1 Research on the Impact of Different Levels of Nature on Children's Development

Louv (2008) mentioned the problem of human lack of contact with nature and referred to various studies that demonstrate the benefits of nature exposure. Playing in natural outdoor environments has been shown to enhance physical fitness, particularly balance and agility, and contribute to a greater sense of self-worth. It has also been associated with lower rates of behavioral problems, anxiety, and depressive symptoms, as well as increased resilience to stress or adversity (Wells & Evans, 2003). Children in nature-based kindergartens exhibit greater flexibility and a preference for creating their own games compared to those in traditional kindergartens. These findings suggest the importance of nature exposure for child development.

The United Nations Children's Fund (UNICEF) mentions that investing in green and blue spaces promotes positive living and health, benefiting children's psychological, physical, and social development. Several studies (Almeida et al., 2022; Arola et al., 2023; Dadvand et al., 2015; Reuben et al., 2019; Zare Sakhvidi et al., 2022; Zare Sakhvidi et al., 2023) have summarized different aspects of child development based on the dimensions of "physiological development," "psychological development," and "cognitive development" across the lifespan. The natural environments children are exposed to can be categorized into three scales. The following sections review the influence of natural environments on the three domains of child development within each scale:

*2.1.1Neighborhood*

Research on the natural environment in neighborhoods often focuses on green spaces, with greenness indices used to measure the extent of vegetation. Regarding studies related to physiological development, higher greenness exposure (NDVI) has been associated with a lower risk of allergies, but there is less significant correlation with proximity to water bodies (Paciência et al., 2021). The soil-adjusted vegetation index (MSAVI) of green spaces shows a slightly stronger correlation with externalizing behavior compared to internalizing behavior (Lee et al., 2019). Higher physical accessibility to green spaces is also related to better adaptation to physical stress (Ribeiro et al., 2019), although there is no significant association between green exposure and asthma risk, but rather a stronger relationship with traffic congestion levels (Putra et al., 2022).

There is relatively limited research on the impact on psychological development, and the findings show no significant correlations. For example, the quantity of green spaces does not show a significant relationship with self-regulation, independence, and emotional aspects (Mueller & Flouri, 2020), and the level of greening in open green spaces and parks does not appear to have a promoting or protective effect on stress and externalizing behavior, sometimes even the opposite (Weeland et al., 2019).

Studies on cognitive aspects also utilize greenness exposure (NDVI, MSAVI) as a measure to predict children's cognitive development during childhood and adolescence, including executive function, memory, and attention. Although there are significant relationships

(Dadvand et al., 2015; Lee et al., 2019), once family or neighborhood socioeconomic status is taken into account, the association between greenness and cognitive development becomes non-significant and is likely influenced by family and neighborhood socioeconomic factors (Reuben et al., 2019).

*2.1.2 School*

There is relatively less research exploring the physiological aspects of school environments, with the main focus being on cognitive development, followed by psychological aspects.

Some studies suggest that outdoor activities in green spaces play an important role in children's mental health (Louv, 2008). Chiumento et al. (2018) conducted a six-month gardening activity in schools in England and found that it was indeed related to improvements in mental health, particularly in emotional well-being and self-help, and also had therapeutic benefits for children with autism (Chang, 2010). It is not limited to gardening activities alone, as shown in the study by Largo-Wight et al. (2018), which indicates that conducting classes in green spaces can also promote children's sense of happiness.

Based on the findings of this literature review, more research at the school level focuses on the relationship with cognitive development. It has been found that exposure to greener environments (measured by NDVI) and long-term classroom experiences in green spaces have positive effects on attention and memory (Dadvand et al., 2015; Largo-Wight et al., 2018). However, some studies suggest that there is no significant difference in attention restoration between classes conducted in green spaces compared to those in gray spaces (Anabitarte et al., 2021). The preliminary judgment of this study is that it may be due to the short duration of exposure to green spaces in the research methods, leading to inconclusive results. The accessibility of urban green spaces around schools and residences is positively correlated with intelligence quotient (IQ), but there is no clear association with the accessibility of water bodies (Almeida et al., 2022). According to Liu and Chen's (2021) research on Chinese schools, they found a positive correlation between the area of green spaces and children's environmental attitudes and behaviors.

*2.1.3 Forest*

Some studies indicate that forest-dwelling families living within 3 kilometers of a forest and with at least 30% of the community's land covered by forests have a very positive impact on dietary diversity compared to non-forest-dwelling families located more than 8 kilometers away from a forest (Rasolofoson et al., 2018). Attending forest schools and engaging in play and interactions in the forest for a period of eight months also has a positive impact on motor skills (O'Brien & Murray, 2007).

The literature review on the psychological aspects also shows a positive correlation. Hong et al. (2021) conducted 72 forest therapy projects in a national forest and found that they contribute to the participants' interpersonal relationship health. Additionally, children attending forest schools for eight months also experience positive effects on self-esteem and self-confidence (O'Brien & Murray, 2007).

The study conducted by O'Brien and Murray (2007) found that students attending forest schools for eight months significantly improved their cooperative abilities, language development, knowledge, and environmental cognition.

Based on the literature review mentioned above, it can be observed that neighborhood-scale studies mostly measure the extent of exposure to green spaces (Arola et al., 2023; Dadvand et al., 2015; Reuben et al., 2019), while some also examine both green and blue spaces (Paciência et al., 2021). Natural resources such as nature museums have received relatively less discussion (Dopko et al., 2019). In contrast, forest-scale studies often use the level of engagement in activities within the environment as a criterion, which better reflects children's opportunities for connection with nature compared to measuring the degree of greenness. Moreover, the natural resource composition of forest environments is more diverse, which may contribute to a more significant association between forest-scale research findings and child development.

Psychologist Kurt Lewin believed that human behavior is the result of the interaction between individuals and their environment. In mainstream education in our country, students spend approximately 6-8 hours per day in the school environment from elementary to high school, making it one of the significant living environments. The school environment also has a certain influence on students (Ho & Chang, 2011). Therefore, this study chose the school as the research scale, and the campus setting ensures relative equality and fairness regardless of social background.

### 2.2 Classification of Natural Environment Manipulation

The definition of the natural environment includes two aspects: (1) intact ecological units without significant human interference, and (2) natural resources and physical phenomena unaffected by human activities. The degree of naturality exhibits a continuum, and there are no absolute values of 0% or 100% naturality.[1] In this study, the scope of naturality falls within the category of intact ecological units, and therefore, the literature review will primarily focus on the commonly used measurement of naturality,

[1] Source of information: Copyright © 2023 Environment and Ecology. http://environment-ecology.com/what-is-environment.html

the Normalized Difference Vegetation Index (NDVI).

*2.2.1Normalized Difference Vegetation Index (NDVI)*

Usually (but not necessarily) observed from space, the Normalized Difference Vegetation Index (NDVI) utilizes the principles of light reflection and absorption to assess the color and evaluate the state of green vegetation growth. It is calculated using satellite remote sensing. The formula is as follows:

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$

NIR: Near-Infrared reflectance; RED: Red reflectance; NDVI: Ranges between -1 and 1. In general, NDVI values are positive for green vegetation (including crops, shrubs, grass, and forests); surfaces such as sand or concrete tend to approach zero, and water bodies display negative values (Huang et al., 2021).

However, in the selected school-scale environment for this study, the possibility of artificial elements needs to be considered. After taking this into account, alternative and more comprehensive classification methods will be explored.

*2.2.2 Plant Ecological Assessment Technical Specifications*

This classification method corresponds to the "Plant Ecological Assessment Technical Specifications" announced by the domestic Environmental Protection Administration. It usually involves interpretation in conjunction with aerial photographs and classifies the environment into the following levels from 0 to 5 based on land use and vegetation composition distribution:

Naturality Level 5: Natural forest areas, undisturbed forests in their natural state, with minimal expected changes in composition and structure in the future. Naturality Level 4: Original grassland areas, which could develop into forests but are restricted to a grassland form due to limiting factors.

Naturality Level 3: Afforested areas, where the vegetation is artificially planted but exhibits long harvesting periods and higher stability.

Naturality Level 2: Agricultural land, areas with artificially planted crops or temporarily abandoned grasslands.

Naturality Level 1: Bare land, areas devoid of vegetation due to natural factors.

Naturality Level 0: Areas devoid of vegetation caused by human activities.

Although this classification distinguishes between artificial and natural environments, the classification of natural compositions beyond green spaces is less clear. Therefore, this classification method will not be used in this study.

### *2.2.3 Land Cover Classification System (LCCS)*

The Land Cover Classification System (LCCS) aims to provide a consistent framework for classifying and mapping land cover. Its primary goal is to overcome the rigidity of land cover classification, as in many cases, it is challenging to easily assign a specific predefined category using other classification systems. In contrast, LCCS offers easier classification and mapping capabilities and can be applied to maps at various scales. From a practical standpoint, the advantages provided by LCCS include: (1) ease of integration; (2) allowing flexible application with available information in specific regions, project budgets, and time constraints; (3) separating data collection from the interpretation process (Di Gregorio, 2005)

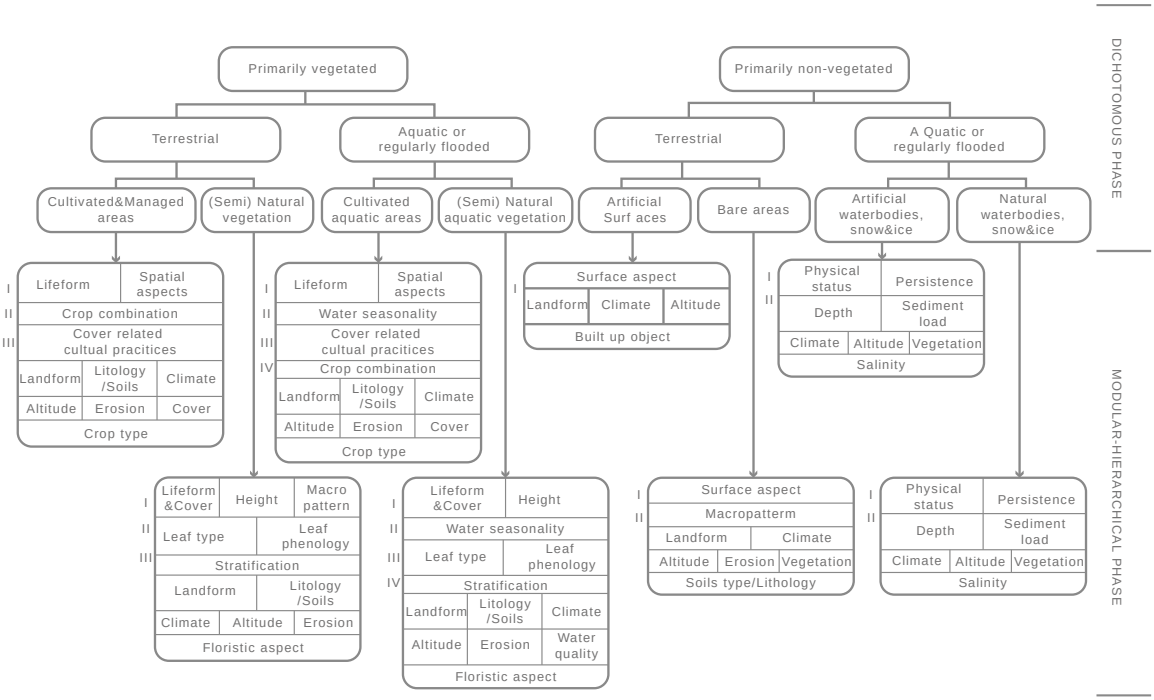


Figure 2. Overview of the Land Cover Classification System
Data Source: Cited from Di Gregorio, 2005

Saleh and Aboelghar (2013) utilized the LCCS classification system to map land cover in North Sinai, Egypt, as their case study. The mapping process can be summarized into four steps: (1) defining the study area, (2) determining the land cover categories, (3) referencing satellite imagery (Figure 3), and (4) creating the land cover map. The

researchers evaluated the accuracy of the final map results (Figure 4), achieving an overall accuracy percentage of 96.14%.

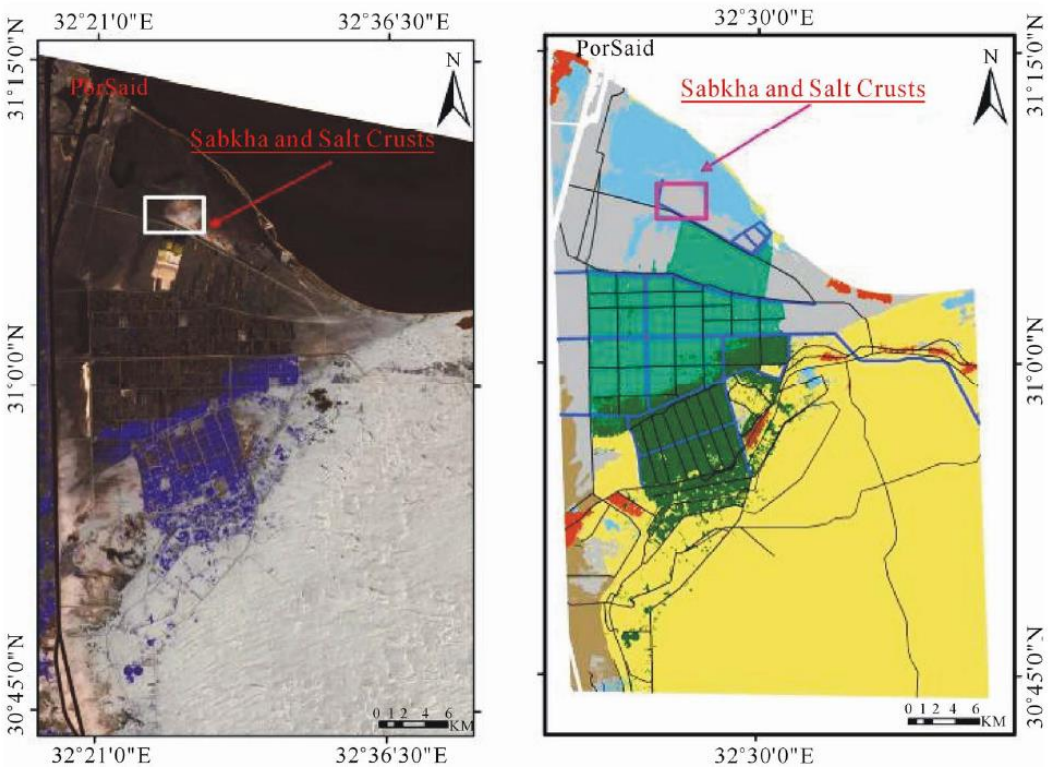


Figure 3. Satellite Comparison Chart for the Study by Saleh and Aboelghar (2013)

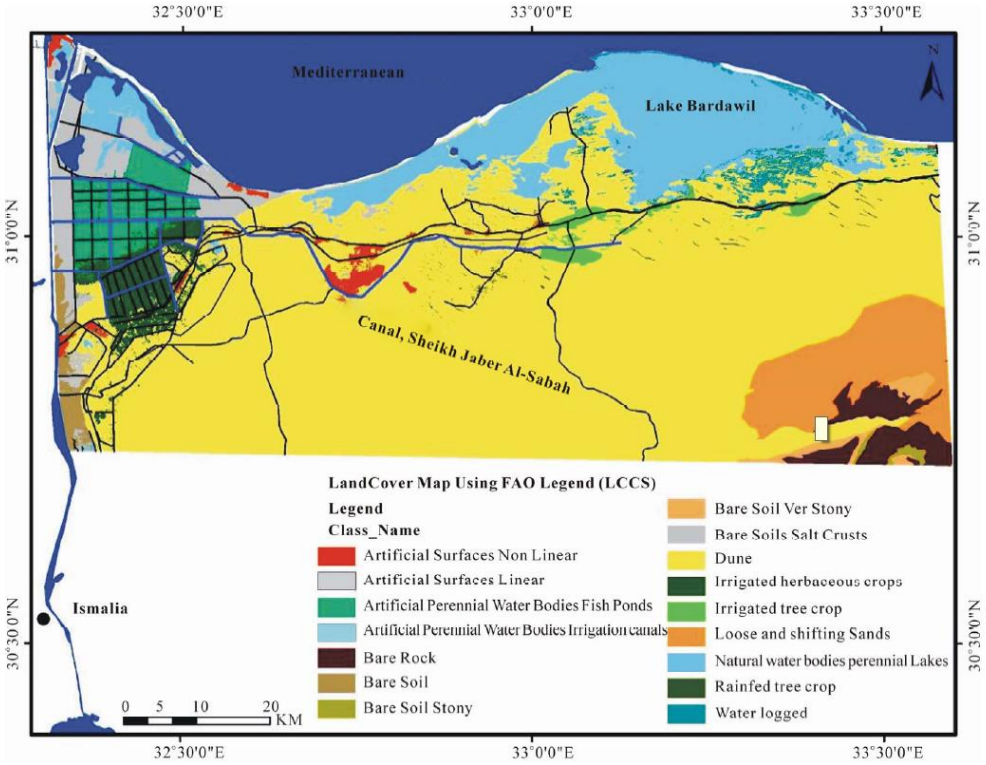


Figure 4. Land Cover Map of the Study Area by Saleh and Aboelghar (2013)

### 2.3 Development of Environmental Cognition

The overall process of human development is often categorized by researchers into three domains: "physiological development," "psychosocial development," and "cognitive development." The development across these three domains is typically interconnected (Adolescent Psychology)[2], where changes in one aspect can impact the development of others, known as a "holistic perspective" (Shaffer & Kipp, 2013). In the context of cognitive development in children, two prominent psychological theories, Jean Piaget's theory of cognitive development and Lev Vygotsky's cognitive development theory, are frequently applied. Piaget is considered a pioneer in this field during the 20th century. He proposed that cognitive development is not simply the accumulation of knowledge in the mind but rather a process aimed at survival and understanding the world. According to Piaget, learning occurs through the interaction of assimilation and accommodation with new environmental experiences, leading to long-term changes. Piaget's theory divides cognitive development into four stages based on age: the

[2] Source of information: Created with support from SUNY OER Services and Hudson Valley Community College. https://courses.lumenlearning.com/adolescent/

sensorimotor stage (0-2 years old), the preoperational stage (2-7 years old), the concrete operational stage (7-11 years old), and the formal operational stage (11 years old and above) (Huitt & Hummel, 2003). Some studies have incorporated this theory into educational planning, using cognitive development theory to design suitable dance curriculum and movements for different age groups in children's dance instruction (Liao, 2012). Additionally, researchers have applied these theories as a basis for comparing the appropriateness of Orff music pedagogy and Kodály music pedagogy in relation to the physical and mental development of children at various stages (Lin, 2020).

According to the aforementioned theory of cognitive development, understanding the world includes the recognition and understanding of the environment. Gifford et al. (2011) define environmental cognition as the process in which individuals attend to complex environments in order to identify important elements and patterns within them. Through perceptual exploration of the environment, individuals develop their understanding of it. Actual environmental perception can vary among individuals due to differences in culture and age, and different perceptual modes can result in diverse interpretations of the same scene.

## 2.4 Different Levels of Natural Settings and Related Interactions Research

### *2.4.1 Natural Settings*

Based on Kellert's (2002) classification of nature experience, this study will review relevant literature on three types of natural interaction experiences:

1. Direct experiences involve relatively natural environments such as forests, riversides, and community parks that are closer to the wilderness.
2. Indirect experiences involve human-controlled and intervened natural environments, such as zoos, vegetable gardens, and farms, which heavily rely on human control. (Chiumento et al., 2018)
3. Vicarious/symbolic experiences involve understanding nature knowledge through multimedia without actually entering natural environments.

The impacts of these three types of experiences on children's cognitive, affective, and evaluative aspects will be examined.

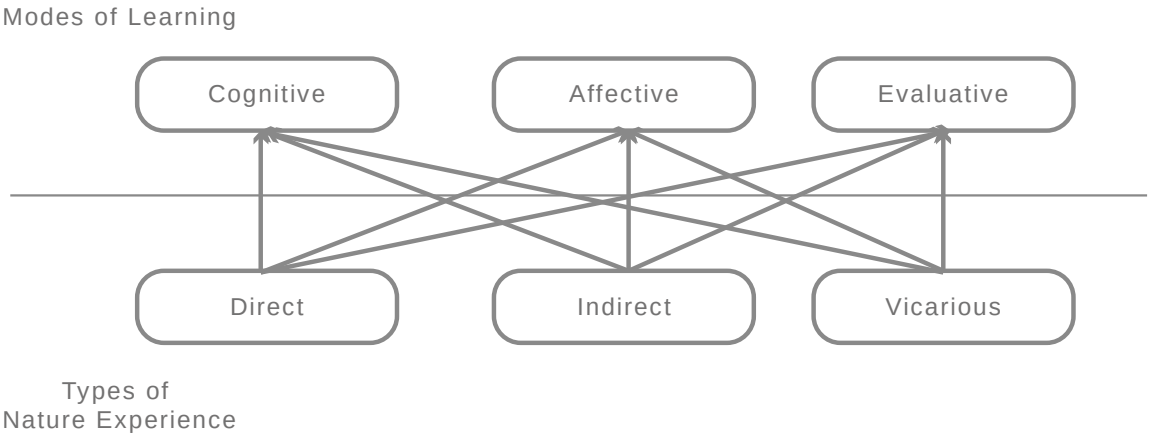


Figure 5. Classification Chart of Natural Activities Experience
Data Source: Cited from Kellert (2002)

This study categorizes the literature review based on the types of experiences mentioned in the first paragraph. From the literature review mind map, it can be observed that the majority of previous studies focused on direct natural interaction experiences. Therefore, this study relies on literature related to direct natural experiences as the foundation and defines it as the normative scope of natural experiences for children.

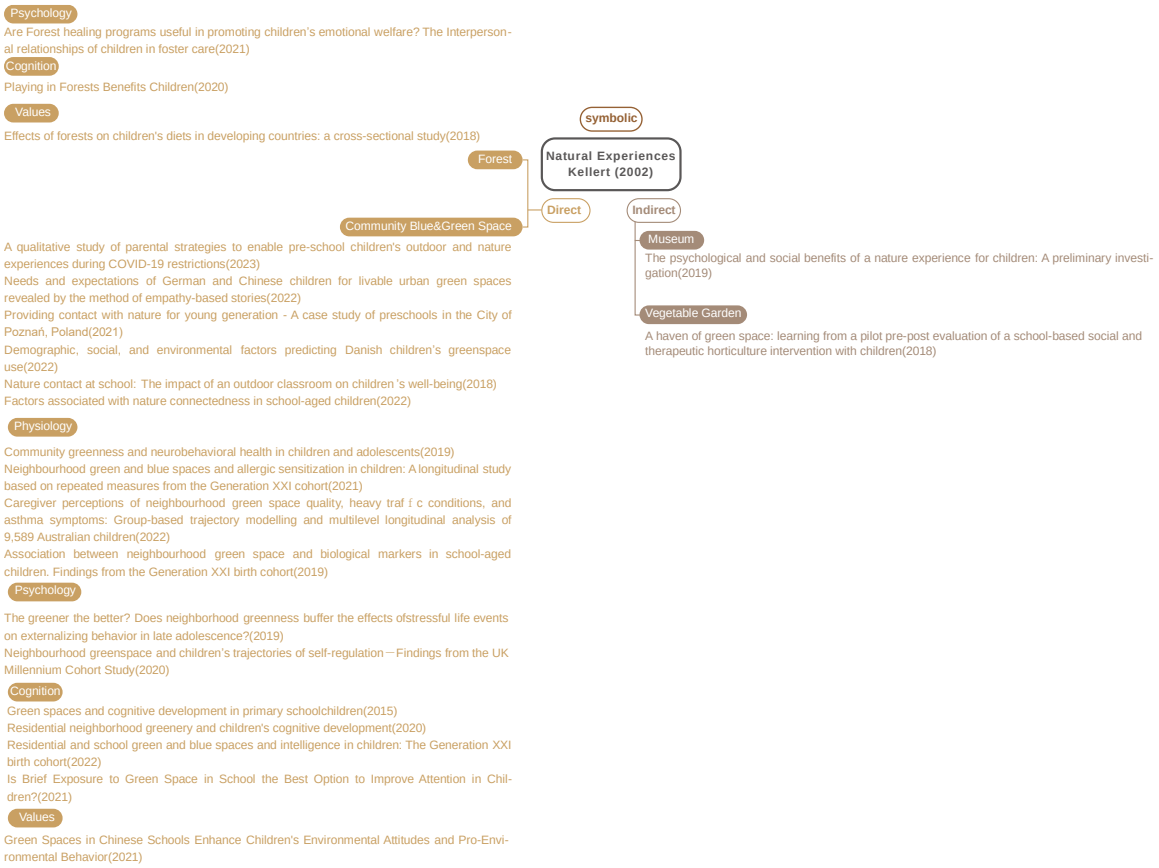


Figure 6. Classification of Literature on Nature Experiences

### *2.4.2 Interaction with Nature*

Environmental educator Cornell (1979) summarized five principles for outdoor teaching experiences in nature:

1. Teach less, share more: Instead of emphasizing cognitive aspects, focus more on emotional and sensory experiences to elicit diverse responses from children. Spend more time sharing their feelings about nature.
2. Be receptive: Listen and be aware of children's feelings. Respect them and provide opportunities for expressing their true thoughts and emotions.
3. Focus students' attention without delay: Capture children's attention before starting an activity, stimulating their keen observation skills and fostering their interest in new discoveries.
4. Look and experience first, talk later: Direct experiences have a deeper impact on children than indirect ones. Encourage them to observe and experience more, without rushing to provide cognitive answers.

5. Foster a joyful learning experience: Create an atmosphere of laughter and happiness throughout the process, as children are naturally attracted to enjoyable experiences and are more willing to learn.

The definition of nature experiences should be to stimulate children's sensory abilities, guide their perception and insight, and evoke joy. The importance of sensory education is also a core educational concept in Montessori's approach to promoting children's development (Chen, Biyun et al., 2018).

### 2.5 Taiwan Experimental Schools

Education environments can be categorized into five types: political, family, school, social, and ecological. Among them, the school environment in Taiwan's education system can be divided into mainstream and non-mainstream systems. The latter is also known as "alternative education" or "ideological education" because it is mostly based on specific educational core principles and exhibits diverse educational forms. In terms of classification, it can be further categorized into school-based experimental education and non-school-based experimental education. The former differs from the mainstream education system in its advocacy and conducts integrated experiments within the scope of schools, while the latter is not limited to schools and can be conducted by individuals, groups (consisting of three or more people), or institutions (Peng, Qianyun, 2010). According to Parenting Magazine (2022), Taiwan's current experimental education system can be further divided into seven categories:

1. Waldorf Education: Based on "anthroposophy," it advocates that each individual possesses inherent qualities and talents. The curriculum emphasizes broad knowledge to promote the holistic development of students' mind, body, and spirit.
2. Montessori Education: Emphasizes interdisciplinary knowledge rather than subject divisions, guiding children to learn from everyday life. It emphasizes active exploration and provides classrooms with practical, concrete, and manipulative materials to help children transition from the concrete to the abstract learning phase.
3. Democratic Schools: Founded on trust in children and the belief that "all children are born curious," it criticizes traditional education for suppressing children's curiosity and learning motivation. Teachers and students collaborate to design the curriculum, and student autonomy is emphasized, with students taking responsibility for managing the school, including participating in school meetings and establishing school rules.
4. Ecological Education: With mountains and forests often located near the schools, the abundant natural environment becomes the students' classroom, providing a different learning experience compared to sitting in a classroom taking notes and

listening to lectures.

5. Expeditionary Learning Education: Students engage in challenging physical activities and participate in high-demand outdoor activities. It not only strengthens physical fitness but also cultivates various non-cognitive skills in children, such as confidence and taking initiative. This learning approach is based on Expeditionary Learning Schools (ELS).
6. Indigenous Experimental Education: Faced with the rapid erosion of indigenous cultures in modern times, this category encourages the establishment of education models that meet the needs of indigenous peoples.
7. Others: In recent years, there has been a rise in institutions focusing on international education, providing an all-English environment while emphasizing students' involvement in sports and the arts, and offering personalized course choices.

Although experimental schools can generally be classified based on the aforementioned educational systems, in practical educational planning, they may involve a combination of curriculum practices. Therefore, this study selects ecological experimental schools in Taiwan and experimental schools that highly incorporate nature into their curriculum as the research subjects, in line with the research objectives.

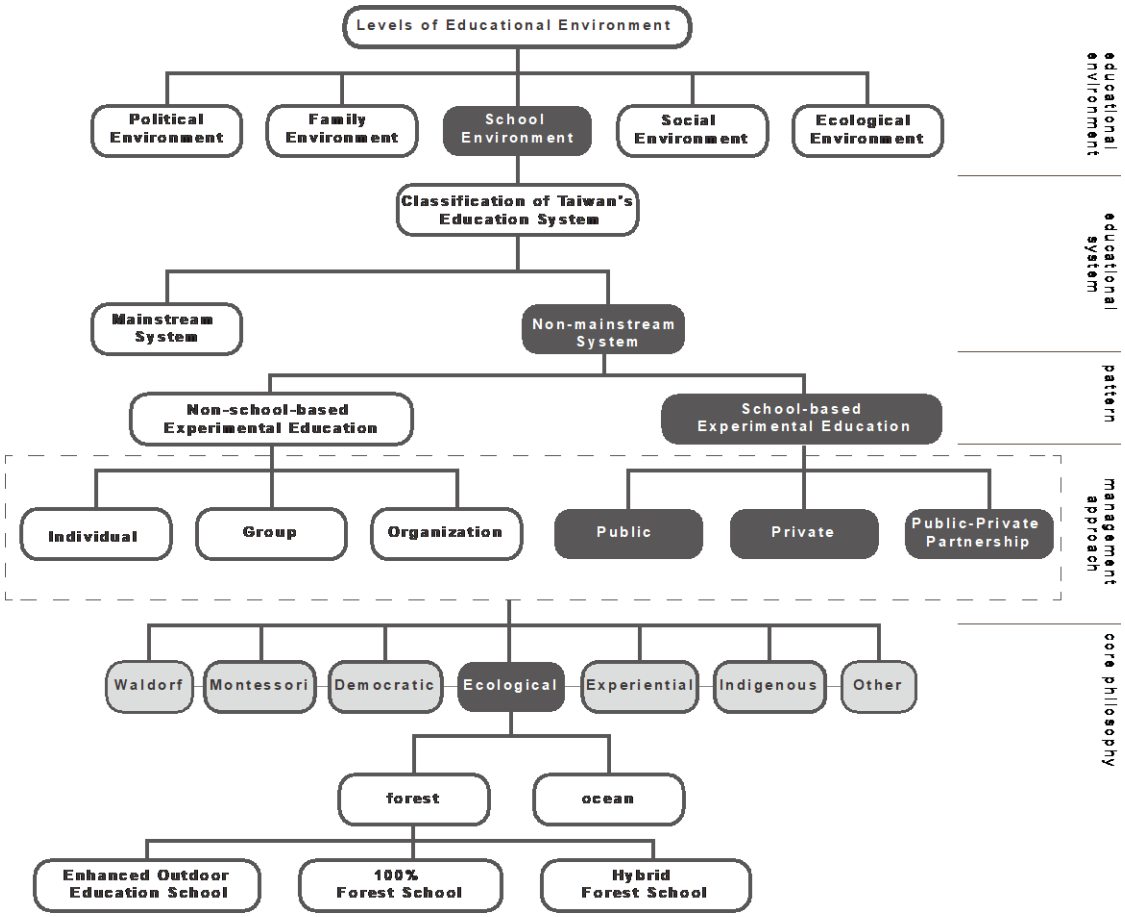


Figure 7. Hierarchy Diagram of Experimental Education

Data source: Self-drawn in this study

## 3. Research Design

### 3.1 Research Framework

This study takes into consideration the guidance and intervention in education and utilizes interviews with teachers as the primary tool to explore how natural resources can support curriculum and their impact on children's environmental cognitive development. The research is divided into three main steps: "Classification of Natural Environmental Resources," "Integration of Nature into Curriculum Planning," and "Data Compilation." Through these steps, the study aims to derive insights into children's nature experiences and their interactive relationships.

The first step involves considering the diversity of natural resources in the research environment. The Land Cover Classification System (LCCS), developed by the Food and Agriculture Organization of the United Nations (FAO), is employed to create visual

representations of the composition of the school's internal and surrounding environments. Subsequently, interviews with teachers are conducted to verify the approaches used in incorporating nature into the curriculum, including resource composition, activity scope, and level of interaction. The interview content is then transcribed verbatim and coded to address the research questions, leading to the analysis and conclusion. Following this, data collection results are analyzed and discussed. Detailed descriptions of each step are provided below, and the research framework flowchart can be found below.

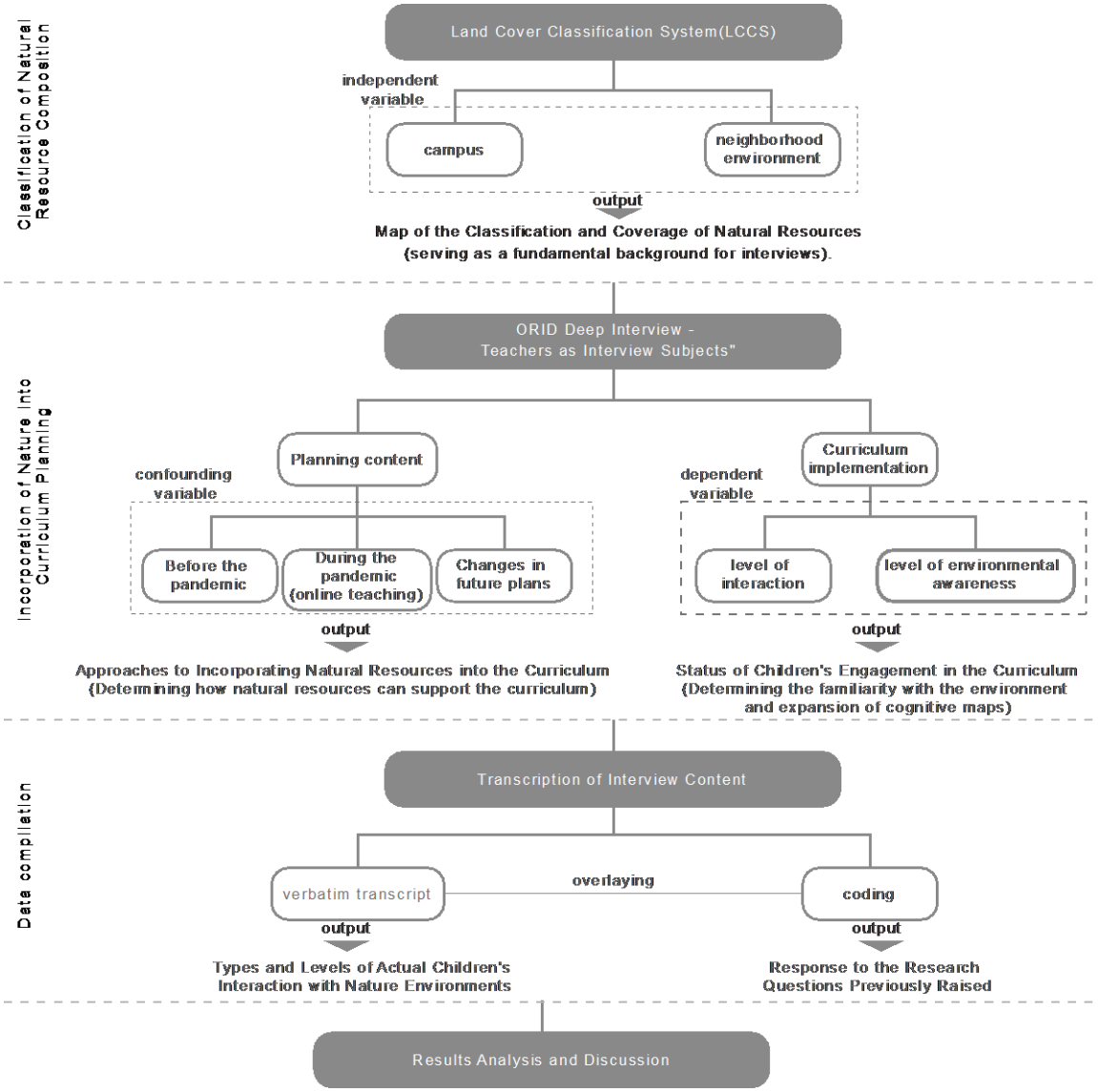


Figure 8. Research Framework Flowchart

### 3.2 Selection of Research Subjects

For this study, a total of 100 experimental primary schools under the category of school-type experimental education were selected from the list provided by the Ministry of Education for the 110th academic year. These schools were then categorized based on their educational philosophies, and those that emphasized ecological education and extensively incorporated natural resources into their curriculum planning were identified as experimental primary schools of interest.

Considering the differences between direct nature experiences in curriculum planning and the online teaching experiences during the COVID-19 pandemic, Taipei City and New Taipei City, which had experienced longer periods of online teaching compared to other cities and counties, were chosen. Among the three selected schools, Xishan Experimental Elementary School and Hutian Experimental Elementary School, located in Taipei City, are both situated within the Yangmingshan National Park. The third school, Zhongzi Parent-Child Experimental Elementary School (Zhongzi Elementary School), is located in the Wulai Bao'an Protection Zone in New Taipei City. After contacting and negotiating with the schools, Zhongzi Elementary School, which showed a higher willingness to cooperate, was ultimately selected as the research subject. The selection process flowchart is presented below.

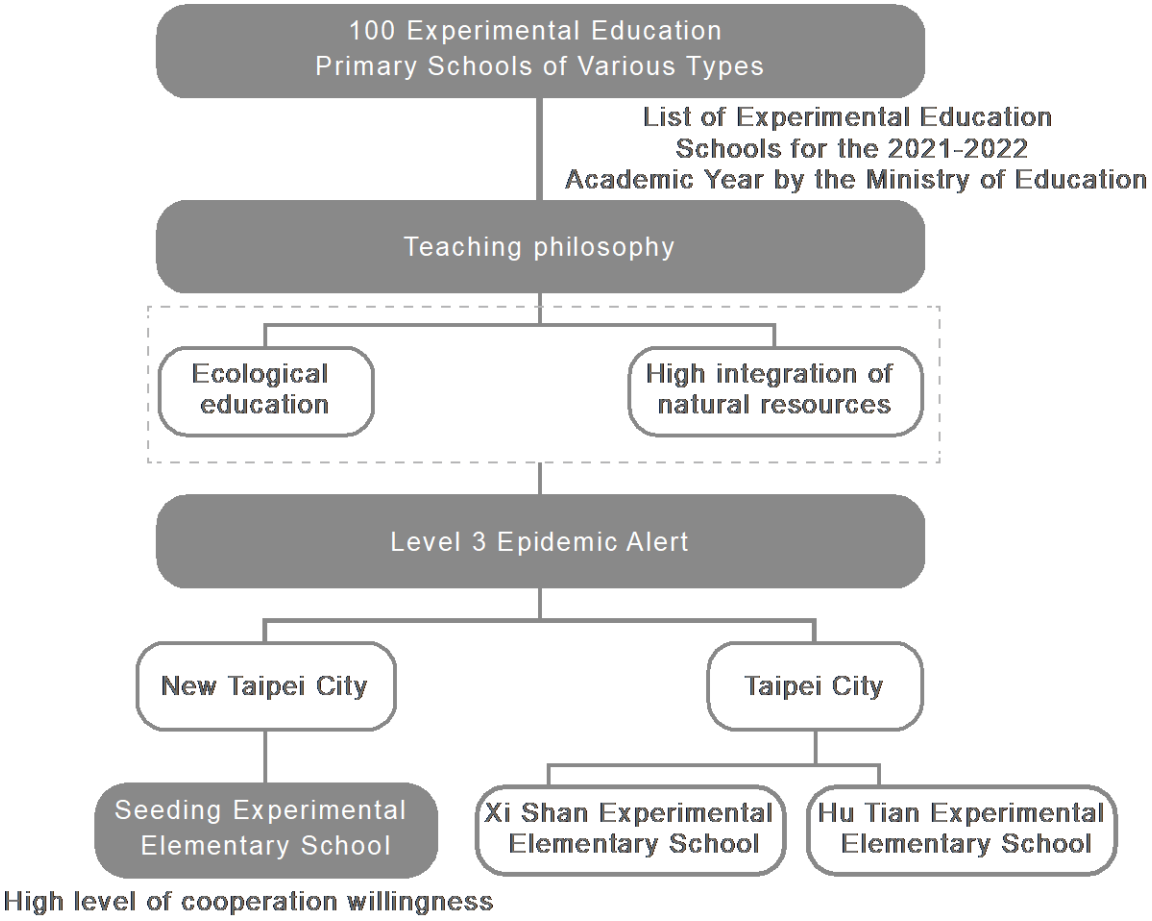


Figure 9. Flowchart of Research Subject Selection Process

### 3.3 Composition and Construction of Natural Environmental Resources for the Research Subjects

Given that previous studies have mainly explored the relationship between the degree of green space and child development, it is important to consider the differences in environmental factors between domestic and international contexts. Additionally, some studies have shown a significant correlation between water body exposure and well-being (Vitale et al., 2022). Taking all of these factors into account, this study incorporates the diverse composition of natural elements. Therefore, the "natural resources" in this study are based on the Land Cover Classification System (LCCS) developed by the Food and Agriculture Organization (FAO) of the United Nations. Rather than limiting the natural resources to green spaces alone, the study considers the physical coverage observed on the earth's surface, including descriptions of vegetation characteristics and whether the features are natural or artificial. This approach helps identify the

composition of the surface in the study area and provides a clearer understanding of the environmental resources in the selected experimental schools for subsequent curriculum integration.

Considering that children may be taken to different locations based on the arrangement of the curriculum, interviews will be conducted to determine the range of physical contact with natural environments. Subsequently, the LCCS classification system will be utilized at the third level of the level-two subzone to create maps.

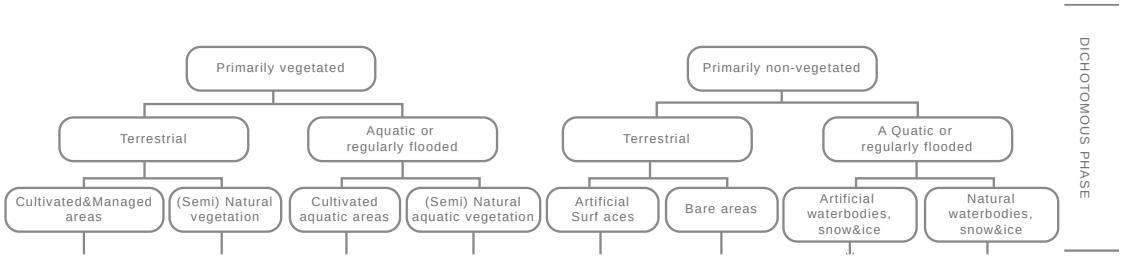


Figure 630. Dichotomous Phase
Data Source: Cited from Di Gregorio, 2005

### 3.4 Experiencing Interaction with Nature at Different Levels

#### *3.4.1 ORID Interviews*

Focused conversation is a conversational approach that centers around a specific topic or goal, aiming to facilitate deep thinking, communication, creativity, and collective wisdom. ORID is one of the specific application models within focused conversation, used to promote meaningful discussions and decision-making. It consists of four stages: Objective, Reflective, Interpretive, and Decisional (Stanfield, 2000).

#### *3.4.2 Interview Content*

This study will employ the ORID focused interview method and develop an interview outline. The interview will focus on the following aspects:

(1) Integration of natural resources in the curriculum by teachers: This part of the interview aims to confirm the scope of activities and the inclusion of natural resources in curriculum planning. It also explores the differences, potentials, limitations, and possibilities for improvement in incorporating natural resources based on the incidental circumstances of the COVID-19 pandemic (online teaching).

(2) Facilitating children's interaction with nature during classroom implementation: Building on the understanding of curriculum planning mentioned above, this aspect further identifies the level of interaction between children and nature. The primary

research subjects of this study are elementary school students, aged between 6 and 12 years, spanning the last three stages of Jean Piaget's cognitive development theory. Their curiosity drives sensory stimulation and cognitive development from concrete object recognition to logical reasoning and abstract concept thinking. Therefore, the study measures and operates on the stimuli, frequency, and duration of sensory experiences to promote environmental cognition development.

(3) Children's level of environmental cognition after participating in the classroom activities[3]: Finally, through the observations made by the teachers during the classes, the level of environmental cognition among participating children will be assessed. This assessment may involve evaluating the children's familiarity with the environment, the expansion of their cognitive maps, or other judgment criteria proposed by the interviewees.

*3.4.3 Pilot Interview and Confirmation of Interview Outline*

Prior to conducting formal interviews, a pilot interview will be conducted with teachers from the research schools to ensure the readability and effectiveness of the interview questions. Based on the feedback received, the interview outline will be revised and finalized. For the pilot interview, Teacher Wenning, who has been teaching at the Seed School for 18 years, will be invited as the interviewee. Teacher Wenning primarily teaches subjects related to holistic development, including physical and sensory development, language, and social sciences. The interview outline will be adjusted accordingly, as shown in the table below:

[3] This item is not within the scope of this discussion.

Table 1. Interview outline

| Interview Activity Planning Sheet - Final | | |
|---|---|---|
| Seeding Experimental Elementary School Teacher Team | Theme: Interaction between Natural Spatial Resources and Children in Experimental Elementary Schools | |
| **Preparation before the interview** | **Steps** | |
| 1.Voice recorder<br>2.Sticky note<br>3.Campus and Surrounding Area Map<br>**Time/Location**<br>Time:2023/05/04-05<br>Location:Seeding Experimental Elementary School<br>**Actual Execution Results**<br>To approach the curriculum from the perspective of teachers, and to understand the integration of nature into curriculum planning, actual interaction with nature, and the level of environmental awareness.<br>**Opening remarks**<br>◦ A brief introduction: Graduated from National Cheng Kung University, a member of the 18th batch of Seed Experimental Elementary School alumni. The focus of the interview content.<br>◦ Introduce the definition of nature integration into the curriculum and guide to fill in basic information.<br>**Closing remarks**<br>◦Thank you for your participation. I would like to inquire about your willingness to assist in future research.<br>◦Casual chat: What are your thoughts and feelings about this interview experience?<br>**Duration**<br>Expected duration for one teacher: 60-90 minutes. | O | 1. Please briefly describe the course planning you are responsible fo r.<br>2. Which parts of the curriculum utilize the natural resources in the surrounding environment?<br>3. Which specific natural resources are used to support the curriculum and how are they utilized?<br>4. What are the activities and locations where natural resources are used to support the curriculum?<br>5. During the pandemic (when online teaching was implemented), which parts of the curricu - lum were adjusted?<br>6. After the pandemic, are there any di fferences in the curriculum planning compared to before the pandemic? |
| | R | 1. What are your beliefs as an educator? How do you perceive the relationship between the curriculum and the natural environment?<br>2. What kind of interactions do you hope children will have with nature in such a curriculum arrangement?<br>3. How do children actually interact with nature during the course?<br>Building upon O5 and O6, what are the di fferences in the level of interaction between children and nature in the curriculum before, during, and after the pandemic?<br>4. What sensory perceptions do children excel in utilizing to engage with nature?<br>What developmental impacts do you expect the curriculum arrangement to have on<br>5. children?<br>Based on your observations as a teacher in the classroom, what influence do you think the<br>6. curriculum has on children's environmental awareness? To what extent does it impact them? |
| | I | 1. Building upon O4, why did you choose these particular natural resources to be included in the curriculum?<br>2. Building upon R5, how do you observe and assess the level of cognitive understanding?<br>3. Building upon D1, what are the reasons for not currently incorporating certain natural resources? |
| | D | 1. Based on the previous course arrangements and observation experiences, are there any approaches to integrating nature into the curriculum that you haven't tried yet but would like to explore further?<br>2. Is there anything important that I haven't asked about but you think should be addressed? |

## 4. Empirical Analysis

Table 2. Basic information of the interviewed teacher

| character | Interviewee | Teaching period | Subject/Grade level |
|---|---|---|---|
| Testing interview | A Teacher | 18 years | 1. Sexual and perceptual development (Lower Grades) |
| | | | 2. Language and Social Studies |
| Actual Interview | B Teacher | 4 years | 1. Nature (Lower Grades) |
| | | | 2. Mountain Activities (Middle/High Grades) |
| | | | 3. Reading and Writing (Grade 3) |
| | C Teacher | 1 years | 1. Mountain Activities (Lower Grades) |
| | | | 2. Atayal (Middle Grades) |
| | D Teacher | 12 years | 1. Mathematics (Grade 1,4) |
| | | | 2. Bicycle (Lower/ Middle/High Grades) |
| | | | 3. Game(Lower Grades) |

### 4.1 Curriculum Planning/Interactivity

From Table 4, it can be observed that during the period of online teaching due to the pandemic, most of the curriculum implementation was suspended. Only symbolic approaches were used to incorporate nature into the curriculum. However, physical interaction with nature is also crucial for children's development. Therefore, an analysis is conducted to summarize the curriculum planning involving nature before and after the pandemic, as well as the level of interactivity for children.

Table 3. Curriculum planning and level of interaction

| Curriculum | Incorporation of Nature Level | | | | Teacher's observation of the level of interaction (through the five senses) |
|---|---|---|---|---|---|
| | Before the pandemic. | During the pandemic (online teaching). | After the pandemic. | Inclusion approach | |
| A-1 | - | - | - | - | - |
| A-2 | Direct | Symbolic | Direct | On a good weather day, take students to the riverside for writing; during the pandemic, incorporate nature through the use of memories. | - |
| B-1 | Direct (2/5)<br>Indirect (2/5)<br>Symbolic (1/5) | Symbolic | Direct (2/5)<br>Indirect (2/5)<br>Symbolic (1/5) | Theme-based understanding of natural species with interweaving outdoor and indoor teaching. During the pandemic, share homemade animal and insect specimens. | Tactile, visual, olfactory, auditory |
| B-2 | Direct (2/3)<br>Indirect (1/3) | - | Direct (2/3)<br>Indirect (1/3) | Arrange the curriculum according to seasons: planting plants in spring, playing by the stream in summer, | Tactile, visual, auditory |

| | | | | | |
|---|---|---|---|---|---|
| | | | | collecting plants in autumn, and making fires in winter. | |
| B-3 | Direct (1/5) Indirect (1/5) Symbolic (3/5) | - | Direct (1/5) Indirect (1/5) Symbolic (3/5) | Guide students to observe outdoors and provide writing assistance based on nature-related writing themes. | Tactile, visual |
| C-1 | - | - | Direct (1/3) Indirect (1/3) Symbolic (1/3) | Explore nature through the understanding of Atayal indigenous culture and engage with nature through the Atayal language. | Tactile, visual, auditory |
| C-2 | - | - | Direct (1/3) Indirect (1/3) Symbolic (1/3) | - | - |
| D-1 | Symbolic (8/10) | Symbolic (6/10) | Symbolic (8/10) | Integrate mathematics application and imagination through stories about the forest. | - |
| D-2 | Direct (8/10) | - | Direct (8/10) | Engage in nature through cycling to specific destinations, inspired by the concept of travel. | Tactile, visual |
| D-3 | Direct (8/10) | NO | Direct (8/10) | Allow students to play in a semi-natural environment through games. | Tactile, visual |

Regardless of whether the curriculum is highly related to nature or not, students are exposed to nature in a direct way through suitable topics. Through interviews, it was found that the sense of touch is the most important among the five senses for children's experiences. Allowing them to touch objects enhances their curiosity. Visual stimuli also play a guiding role in encouraging children to use their sense of touch. Additionally, taste experiences can increase children's attention, and teachers often incorporate nature experiences with food, even encouraging students to observe and find edible plants along walking routes. Most teachers have observed that among the five senses, hearing

is the least conscious sense for children. Sounds are not a prominent aspect of their nature experiences.

### 4.2 Natural Environment Layering

Based on the aforementioned curriculum planning and the level of children's interaction with nature, it can be mapped onto the composition of the natural environment. Through teacher observations, it was found that in addition to designated environments with high interaction in the curriculum, walking areas are particularly familiar to children and provide opportunities for close sensory interaction. Along these routes, plants, animals, and artificial water channels serve as objects of interaction for children, offering a linear space where visual, tactile, and gustatory senses are highly engaged.

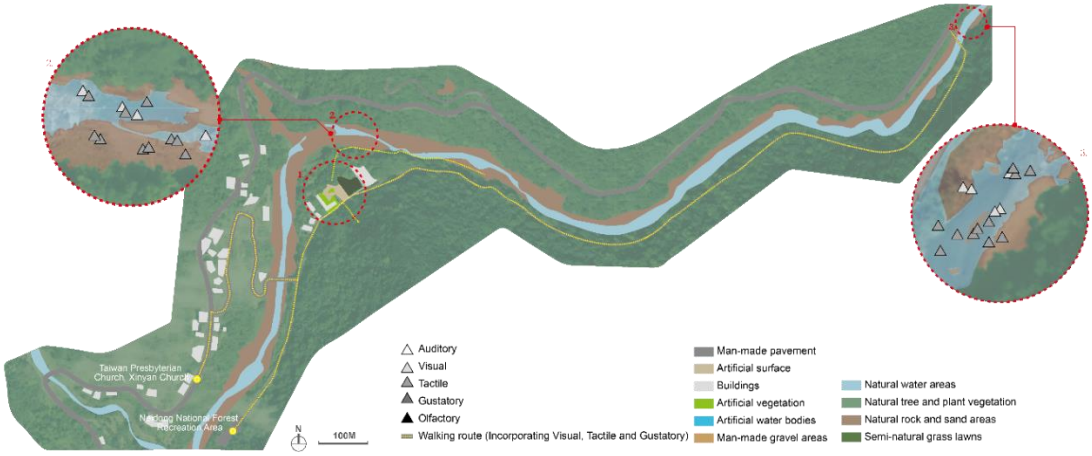


Figure 641. Composition of natural elements within walking range and level of children's interaction with nature

Data source: Reference to aerial photographs from the National Geographic Information System. The diagrams in this study were created by the researchers.

The frequently designated outdoor spaces outside the school encompass natural water areas and sandy regions, providing opportunities for children to engage in water-related activities such as wading, water-floating, diving, catching fish and tadpoles, and stream tracing. These activities promote sensory interactions involving touch and vision. Within the school premises, the use of natural tree vegetation and artificial plants is common in curriculum integration. In addition to visual and tactile interactions, the aroma of fruit trees is often used to guide olfactory interactions among children. Additionally, semi-natural grassy areas, artificial gravel regions, and man-made water features serve as curriculum spaces. In these areas, children primarily engage in visual and tactile

interactions, including observing animals and plants, collecting firewood, and digging soil as part of the curriculum activities.

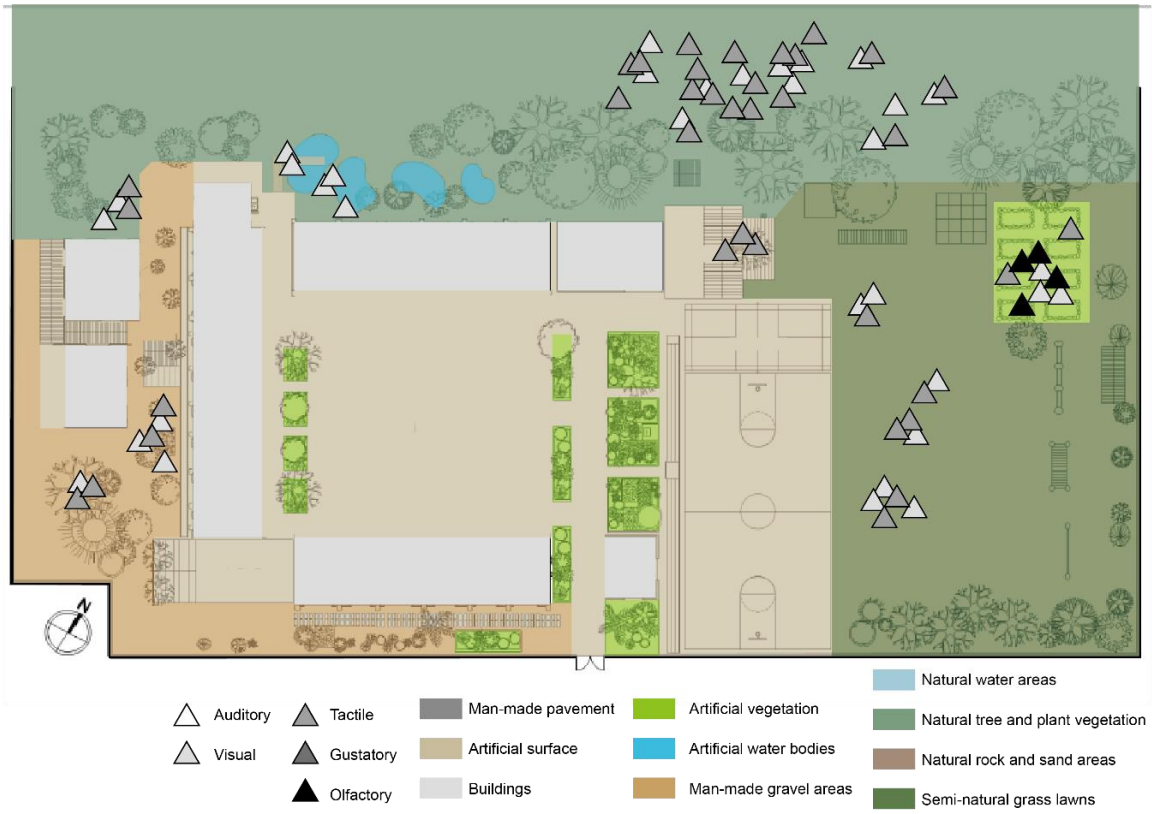


Figure 12. Level of Interaction of Children with Nature within the School Campus

Data Source: Base map adapted from Tsai, J. R. (2013), created by the researchers in this study.

### 4.3 Synthesis Analysis

From the perspective of natural components, both direct and indirect natural environments play a supportive role in the curriculum. However, in direct environments, the diversity of organisms allows for more observations and interactions. By creating an atmosphere that strongly supports tactile experiences, coupled with initial emphasis on visual and gustatory stimuli to stimulate children's interest in interacting with nature, the goal is to enhance tactile sensory stimulation and promote natural interactions. For children, tactile experiences are considered the primary mode of interaction.

Walking is the most suitable way to connect with the natural surroundings in the neighborhood. Although the scope of perception within the school environment is limited, compared to cycling or taking a car to specific natural sites, walking allows for a

higher level of engagement with nature. Through the tactile, visual, and gustatory senses, children can have a linear interaction with the natural environment, which serves as the fundamental basis for their engagement.

## 5. Research Findings

### 5.1 Incorporation of Natural Environmental Components in the Study Setting

The research findings reveal that the school included a significant amount of natural elements in its curriculum, making use of the existing resources in the surrounding area. These include abundant natural vegetation, natural water areas, and some artificial natural resources such as artificial vegetation, artificial water bodies, and certain areas with artificial gravel within the school campus. These components provide opportunities for children to continue their classroom experiences and maintain continuous engagement with nature. Considering safety requirements, opportunities for outdoor nature experiences were implemented within the classroom, utilizing nearby natural trails, streams, sandy and rocky areas along the creek, roadside ditches, as well as chicken coops in the neighboring community. Both natural and artificial environments were major and minor components integrated into the curriculum.

### 5.2 Impact of the COVID-19 Pandemic on Nature Engagement Opportunities in the Curriculum

Regarding curriculum adjustments during the pre-pandemic, pandemic, and post-pandemic periods, the research indicates that these unexpected events indeed affected both direct and indirect opportunities for children to engage with nature. During the online teaching period, many nature-based activities that involved direct contact were suspended, and the remaining activities were replaced with symbolic experiences. Apart from utilizing videos, photos, and teachers sharing their own animal specimens and plants as input-based experiences, children were also guided to engage with nature through output-based activities such as writing and recalling. After the online courses concluded, the school returned to the pre-pandemic approach of incorporating nature, relying heavily on direct and indirect nature experiences to support the curriculum.

### 5.3 Tactile Sensation as the Primary Sense for Children's Interaction with Nature

Through interviews conducted in this study, it was observed that the sense of touch played a crucial role in children's interaction with nature, as reported by most teachers. Even in natural environments, if tactile sensation and its interaction were not available, it would weaken children's interest in engaging with nature. Therefore, when selecting environments, it is important to consider not only the composition of the natural

environment but also whether it supports tactile experiences. Visual and gustatory senses can be used as initial inducements.

### 5.4 Results and Recommendations

The school's curriculum arrangement and environmental provisions serve as mediums for children to interact with nature. Direct and indirect physical experiences with nature provide greater sensory interaction for children, with particular emphasis on supporting tactile, visual, and gustatory experiences. Therefore, it is recommended that schools focus on incorporating direct and indirect nature experiences in their curriculum and create an encouraging environment for children to use their sense of touch to engage with nature, thereby increasing opportunities for interaction between children and the natural world.

Further research can be conducted using the data collected in this study to delve deeper into children's cognitive development in relation to their environment. Additionally, adopting the perspective of the researcher and employing classroom observation as a means of assessing children's state can serve as the basis for designing questionnaires on children's environmental cognition. By adopting a three-fold perspective, a more comprehensive description of natural interaction can be achieved, and the relationship between environmental cognition and development can be validated. This deeper understanding can provide valuable insights for future curriculum arrangements that incorporate nature and offer recommendations for environmental adjustments.

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