

Article

# Awareness and Attitude of College Students Majoring in Landscape Architecture towards the Sustainable Development

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**Abstract:** Reflecting the interest in sustainable development (SD), researches on the attitude toward SD have been steadily conducted for various groups. To explore the characteristics of awareness and attitude of college students majoring in landscape architecture towards the concept of SD, this study has two research questions; to analysis latent classes according to the learning participation pattern (research question 1), and to explore student characteristics that influence the classification of each classes (research question 2). The latent class analysis (LCA) was used to identify the combination of relationships found in the classes based on similar patterns among the characteristics of people rather than the relationship between observed variables. A total of 495 students majoring in landscape architecture, 222 males and 275 females, are participated in this study. The results of this study are as follows. First, six latent classes were extracted in relation to attitudes toward SD. Second, college students majoring in landscape architecture tend to view the concept of SD from an ‘environmental’ and ‘environmental and economic harmony’ point of view rather than from an ‘environmental, social, and economic’ point of view. Third, grades and educational experiences were found to have a significant effect on the probability of belonging to a specific latent class for SD. Finally, based on these results, we suggest a method for organizing interdisciplinary courses to comprehensively access the ‘environmental, social and economic’ areas of the curriculum.

**Keywords:** sustainable development; landscape architecture; latent class; curriculum

## 1. Introduction

The UN’s Sustainable Development Goals (SDGs) urges humankind to participate in the effort to accomplish the goals described in the SDGs. A field of landscape architecture is an integral area of sustainable urban environment. Landscape architecture industry is closely related to improving the health and welfare of the people, revitalizing the city and improving the living environment, and creating jobs. Then, how do college students who major in landscape architecture understand the concept of Sustainable Development (SD), and do they differ in attitudes toward SD depending on their grade level or education experience for SD? These questions are of great social significance in that it can serve as a basis for predicting the direction of decision-making and policy-making in relation to the environmental industry, as well as demands to address academic curiosity. However, studies of the attitude of college students majoring in landscape architecture on the concept of SD have not been carried out [1,2].

Awareness of individual and group activities is critical to successful collaboration [1]. Attitude refers to the readiness of a person’s response to an event, problem, object, or person, based on any

recognition, emotion, and assessment. Attitudes include cognitive, emotional, and behavioral factors, and are acquired through the repetition of direct experiences or learning. It is important to identify the awareness and attitudes of members of society on SD. Reflecting this situation, recognition of the concept of SD [2,3], attitudes to the relationship between the environment and the economy [3–5], and research on the awareness of SD [6], are continuously being conducted. Comparing the study of Choi et al. [3] who surveyed the attitudes of prospective teachers on SD and a study of Jaegal et al. [4], who studied the attitudes of citizens on SD, these two studies used different methods, but they similarly examined SD through the relationship of ‘economic’ and ‘environment.’ When discussing SD, economic growth and protection of environment have long been perceived as conflicting values. Research that examines the relationship between the economy and the environment can be meaningful in that it reflects this rundown. However, there is a limit in that SD has not sufficiently reflected the changes that are approaching the three pillars of environment, economy and society. In addition, Choi et al. [3] included the question, ‘if the economy develops, environmental problems can be solved with science and technology.’ This question is included in the survey to examine the relationship between economic growth and environmental preservation. However, empirical verification of the relationship between economic development and the development of science and technology under the premise of this question should be carried out. This is because, along with the technologically driven view that the development of science and technology contributes to solving the ‘environmental problem’, the ecological environmentalist view that criticizes it also exists as an alternative. The fact that two views coexist suggests that in order to shed light on the attitudes of SD, it is necessary to examine the perception of the relationship between science and technology and environmental issues.

In previous studies that have investigated awareness and attitudes towards SD so far, researchers mostly have used methods that identify the types of concepts of SD in advance and then request to respondents to select items similar to their attitudes after setting up ‘other’ items to capture responses that do not correspond to those items. Or, after asking questions about the environmental relations and economic relations such as ‘Environmental conservation is more important than economic growth’, based on the responses, a method of investigating the recognition of SD has been used [2]. However, this method does not sufficiently identify the interrelationships between the sub-levels of the concept of SD, and it is difficult to categorize the types of perceptions of SD. It is not possible to obtain accurate information about what type of recognition exists in content categorized as ‘other’, and there is also a limit to understanding the overall type of recognition through the analysis of individual questions. Latent Class Analysis (LCA) can be used as an alternative method to complement these limitations. LCA is a method that discovers potential classes based on the type of individuals’ response to a set of observations.

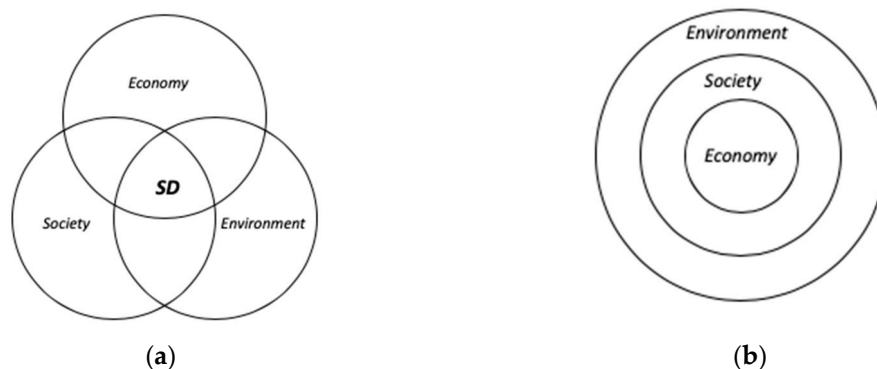
The purpose of the study is to explore the types of attitudes among landscape and university students toward the concepts of SD through LCA methods and to identify differences in the probability of belonging to a group depending on their academic or education for sustainable development (ESD) experience. In addition, based on the results, this study aims to present implications related to the university’s curriculum in terms of ESD.

## 2. Changes in the Concept and Perspectives of Sustainable Development

SD is now one of the most important concepts defining society in the 21st century. The term ‘sustainable development’ became popular in the 1987, as the World Commission on Environment and Development (WCED) published *Our Common Future* [7,8]. Since the concept of SD emerged on the basis of ‘importance of environment and necessity of management’, it came to be understood as ‘economic development considering environment’, which is compatible with environment and economy [9]. The concept of SD, which was approached from the framework of a permanent relationship with the economy and the environment, was changed to consider the three dimensions of environment, economy, and society at the 2002 World Summit on Sustainable Development. The ‘environment’ dimension covers the impact of human activities on the environment, taking into account the physical

and natural environment and its vulnerability, and seeks to preserve the environment for the ultimate purpose. On the other hand, the 'economic' dimension aims to promote economic development by recognizing the effects of economic activities on society and the environment and the limitations of economic growth. The 'social' dimension aims to promote the healthy lives of its members, and to promote welfare, human rights, and social justice through understanding of social actors [10,11].

For these three-dimensional relationships, Figure 1 illustrates alternative views [12]. Figure 1a, the Venn diagram model shows a perspective of approaching SD in an integrated way through a balance between the three dimensions of economy, environment and society. In this regard, criticism has been raised that it is not clear what the balance looks like. In addition, concentric circles such as the model of Figure 1b, the Concentric circles model, were proposed, emphasizing that economic and social systems are based on 'environment'. This position focuses the 'development of society and economy based on environment'. In this view, the social system and the economic system are the secondary products of the environmental system, which emphasizes that society and the economy cannot exist without the earth or the environment. In other words, this model emphasizes that the economic and social systems are subdivisions of the environmental system, insisting that it is appropriate for the environment to exist outside the concentric circles.



**Figure 1.** Two perspectives on the environment, society, and economy: (a) Venn diagram model; (b) Concentric circles model.

Based on the environmental-economic-society perspective, the concept of SD can be summarized as follows [13]. The first is the development that can sustain ecological capacity with environmental sustainability. The concept emphasizes the protection of biodiversity, the restriction of environmental capacity, and the conservation of natural resources. Second is social sustainability. It refers to social justice, equal opportunity, and protection from social disadvantages for the supply of goods and services, emphasizing the possibility of future generations and equity among classes. Lastly, economic sustainability has a meaning of pursuing the improvement of quality of life by forming a competitive economic structure in the long run.

As the concept of SD has evolved, many studies and ESD have been carried out in countries around the UN. In order to achieve the purpose of SD, which aims at environmental conservation and economic development, major international organizations implement the principles and vision of all stakeholders including government, civil society organizations, corporations, and schools. It has been stressed that, and in addition, ESD [14–16]. In addition, UNESCO and UNEP under the UN have emphasized that environmental education and training should be provided to current and future generations in order to maintain a sustainable environment and a sustainable society [17–20]. Accordingly, the UN and UNESCO proclaimed the Decade of Education for Sustainable Development (DESD) and actively promoted various measures [17]. Countries such as the United Kingdom, Ireland, the United Kingdom, and Australia have also formulated national strategies for SD and have more specific roles in education for SD [6,21–23]. On the other hand, the understanding of SD is somewhat different from country to country, so it is necessary to supplement this part through environmental

education, and there is increasing argument about the necessity of an educational approach for students, teachers, and the general public [23–27]. The role of ESD thinking to cope with sustainable society [28]. Fundamentally, since environmental problems originate from the human perspective of the environment, an educational approach is most necessary and effective even in a preventive level [3,29–31].

Oh and Lee [24] and Choi et al. [32] found that ‘welfare’ was sometimes included in the survey questionnaire to investigate the relationship between the environment and the economy. ‘Welfare’ implies a satisfactory state of abnormalities in human life, and at the same time includes specific implementation activities that are oriented toward those conditions. This means that welfare can be approached with a broad concept that embraces both economic and social aspects. Given this, it is sufficiently possible to include ‘Natural damage can be allowed for social welfare’ as one of the questions to analyze the relationship between the economy and the environment. However, when approaching SD in three aspects of the environment, economy and society, the ‘society’ dimension aims for the healthy living of its members and for welfare, human rights, and social justice.

There is a limitation to measure in one question the dynamic relationship of ‘environment, society, and economy’ that constitutes SD. The choice of which sector to allocate a limited national budget is meaningful as a measurement tool for analyzing relationships to society, the economy and the environment in that it represents the value of an individual or society. This is because, in the process of allocating budgets for the establishment and promotion of policies in the country, the value of the budget is reflected in the society. Budgets that must be arranged by the state include: (1) ‘economic budget’ directly related to economic growth, such as highway construction costs, commodity purchase funds to stabilize agricultural and fishery prices, funds to develop industrial complexes, and airport and port construction funds, and (2) ‘Environmental budget’ for renewable energy, the development of resource circulation system through development, energy conversion, and conservation of natural environment and biological resources, and (3) ‘social welfare budget’ to support the socially disadvantaged, such as the expansion of social services to improve the quality of life of the socially underprivileged, such as low-income people, the elderly, the disabled, and multicultural families. Therefore, it is appropriate to investigate the perception of the relationship between society, the environment and the economy through the question of ‘a budget should be allocated first to policies for the socially weak’. Based on the analysis and discussion of previous studies, this study intends to approach the relationships between ‘environmental and economy’, ‘science and technology and environmental issues’, and the social aspect as a concept of social welfare related to ‘the priority of the socially underprivileged’ in order to investigate the attitude toward SD.

### 3. Materials and Methods

#### 3.1. Latent Class Analysis

LCA is a mixed model that assumes there are fundamentally unobserved categorical variables that divide the population into mutually exclusive and exhaustive latent classes [33–35]. The basic structure of the LCA can be defined as a statistical procedure comparable to the factor analysis that allows the extraction of individual groups (‘potential ranks’) that are homogeneous for observed nominal or ordinal scale variables [36]. Similar to factor analysis, latent classes are extracted in such a way that the correlations between the observed variables ought to vanish completely (‘local statistical independence’). This is a stochastic cluster analysis method that classifies latent subgroups based on observational variables [37]. This has the advantage of being able to first extract the most appropriate number of potential class in relation to the attitudes of landscape and university students toward SD, and analyze the probabilistically whether the objects of the study will belong to any of the sub classes.

In the field of psychology, it is common to use cluster analysis procedures to identify the types of students with different attitudes to research methods and statistics [38]. However, the disadvantage of cluster analysis is that it makes many assumptions, such as the choice of distance measurement

or the choice of clustering method (hierarchical-agglomerative or divisive). These pre-decisions have different effects on the results of a cluster analysis. Unlike cluster analysis, LCA is a kind of statistical model used to detect and test types called ‘latent classes’. It requires fewer pre-decisions than common cluster analysis procedures do and bases on efficient algorithms for parameter estimation (maximum likelihood). Further, it offers a broad range of different models (LCA, IRT models, multilevel models, and more; [39]). LCA does not simply validate relationships among observational variables. This has the advantage of being a person-centered analysis method that can identify combinations of relationships found within individuals or groups based on similar patterns between characteristics that participants have. Through this method, latent classes related to students’ attitudes towards SD can be analyzed, and members belonging to each group can be classified.

### 3.2. Participants

In order to analyze the latent class on the attitude of landscape architecture majoring college students towards concept on SD, a survey method was used with landscape architecture major college students in South Korea. Among a total of the 510 responses from four universities located in Seoul, only 497 copies were selected for analysis except the incomplete responses. Table 1 shows the distribution of genders, grades, contact experiences of SD terminology, and whether or not there are experiences of ESD at university. Web-based survey method was used for four weeks from October to November 2018.

**Table 1.** Distributions of participants.

	Sortation	Frequency (Number)	Percentage (%)
Gender	Male	222	44.7
	Female	275	55.3
Age	~19	29	5.8
	20~24	431	86.7
	25~29	34	6.8
	Over 30	3	0.6
Grade	1 (Freshman)	161	32.4
	2 (Sophomore)	108	21.7
	3 (Junior)	116	23.3
	4 (Senior)	112	22.5
Learning about SD Terminology	Exist	230	46.3
	None	267	53.7
Route to Learning SD Terminology *	Middle and High School Classes	104	20.9
	University lecture	151	30.4
	Media (newspapers and broadcasting)	89	17.9
	Internet	106	21.3
	Books	11	2.21
	Etc.	36	7.24
Experience of ESD	Exist	158	31.8
	None	339	68.2

\*  $p < 0.05$ .

A total of 495 students majoring in landscape architecture, 222 males and 275 females, are participated in this study. By age group, 29 people under 19 years old, 431 people between 20 and 24 years old, 34 people between 25 and 29 years old, and 3 people over 30 years old, the most common



age group was 20 to 24 years old. By grade level, first graders participated most, with 161 first graders, 108 s graders, 116 third graders, and 112 fourth graders. Compared to the experience of contacting the term 'SD', 46.3% answered 'experienced' and 53.7% answered 'no experience'. As a result of a questionnaire survey on respondents who responded to the term, the rate of contact with regular classes such as middle and high school class (20.9%) and college class (30.4%) was high. About 30.8% of the respondents answered through newspapers, broadcasting, internet, and liberal arts. In relation to the distribution of experiences of ESD in universities, about 31.8% of the respondents have the characteristic of having education experiences of SD in universities.

The four universities selected for the case study have similar curricula for undergraduate students in the landscape department. It is considered a period of cultivation of basic knowledge of first grade landscaping, and students learn and experience the various subjects and approaches of landscape architecture. In general, the curriculum is organized as follows: (1) Basic theories for landscaping such as Introduction to Landscape Architecture and dendrology; (2) design practical training such as basic design method, computer-based design technology; (3) basics of landscape architecture design for learning how to plan or design, construct, and manage outdoor space. Second graders usually have access to the core contents of landscape architecture that they must learn in the course. The second-year curriculum covers the knowledge systems and technical aspects of landscape architects, including trees and plants, landscape materials, digital media, and information analysis tools, and historical theories. In parallel, a major curriculum integrating theory and practice is conducted through design studio for gardens, parks and open spaces. In the third grade, students will deepen the core basic theories learned in the second grade and offer diversified courses to suit students' aptitude and interest. Students will learn advanced subjects such as landscape theory, landscape history, integrated environmental design, environmental ecology, tourism leisure planning, landscape structure, and landscape accumulation. In addition, integrated project-based training is conducted through design studios covering street-level, complex, urban and infrastructure at urban scales. In the 4th grade, students learn how to derive creative alternatives and rational methodologies by exploring topics and destinations based on their problem consciousness based on their accumulated knowledge and experience through a graduate design studio.

### 3.3. Variables

This study analyzes the types of latent classes for SD among college students majoring in landscape architecture, and identifies the differences in the probability of belonging to latent classes according to the grade and experience of SD education. Accordingly, this study set up subordinate variables of this study as perception and attitude toward SD. In order to establish indicators for the concepts of SD, the literature review considers environmental, economic and social perspectives [2,25,40–42]. A preceding study that analyzed SD attitudes in order to select indicators reflecting the attitudes toward SD [2,4,24].

Sub-indicators for measuring attitudes toward SD include the assessment of urgent tasks for SD, the relationship between the environment and the economy, the relationship between the environment and society, the relationship between science and technology and environmental issues, society and the economy. And relationship with the environment. In order to measure the perception of the prerequisites for SD, we used the items used in previous studies [2,3,43].

In order to construct a questionnaire for analyzing the relevance of the lower levels of SD, among the seven items developed by Choi et al. [32], the question 'Environmental conservation is more important than economic growth' and 'Economic growth must be achieved even if the natural environment is damaged' were used without modification. The view that 'Environmental conservation is more important than economic growth' and 'Economic growth must be achieved even if the natural environment is damaged' seem to be mutually exclusive, however both items were included to reflect the findings of the group that could have both perspectives in the survey.

However, out of seven questions, a question of ‘If the economy develops, technology can solve environmental problems’ was modified to ‘Science and technology can solve environmental problems’ in order to analyze the perspective of the relationship between science and technology and environmental problems. In this regard, ‘Natural damage can be allowed for human welfare’ was changed to ‘Natural damage can be allowed for social welfare’. In order to measure the relationship between ‘society’ and the economy or the environment, we borrowed the survey items from the previous study of Oh and Lee [24]. Based on the questionnaire used in the previous study, the questionnaires for this study were finalized and reviewed and revised by an environmental expert. A total of sixteen items were constructed to measure dependent variables (Table 2), and the reliability was high as Cronbach  $\alpha$  value of 0.802.

**Table 2.** Dependent variables.

Variables	Measurement Variables	No	
Awareness of the conceptual elements of sustainable development (SD)	Sustainable development includes ‘new science and technology development to reduce environmental pollution’.	1	
	Sustainable development includes ‘reacquiring natural resources for human benefit within environmental capacity’.	2	
	Sustainable development includes ‘prioritizing nature over human needs in the development process’.	3	
	Sustainable development includes maintaining stable economic growth in the long term’.	4	
	Sustainable development includes ‘the importance of local production and local consumption’.	5	
	Sustainable development includes ‘help people from poverty, hunger and disease’.	6	
	Sustainable development includes ‘social development that recognizes the needs of everyone’.	7	
Evaluating the urgent task for sustainability	Conservation of the natural environment is urgently needed for sustainable development.	8	
	The development of basic science is urgently needed for sustainable development.	9	
	Economic growth is urgently needed for sustainable development.	10	
	Human rights and social justice are urgently needed for sustainable development.	11	
	Attitude toward SD	Relationship between environment and economy	Economic growth must be achieved even if the natural environment is damaged.
		Environmental conservation is more important than economic growth.	13
Relationship between environment and society		Natural damage can be allowed for social welfare.	14
Relationship with society, economy and environment		Budget should be allocated first to policies for the socially disadvantaged.	15
Relationship between science and technology and environmental issues		Science and technology can solve environmental problems.	16

The independent variables selected in this study are grade level and SD education experiences. Grade variables were converted to Y1, Y2, and Y3 variables to carry out multiple logistic regression analyzes to identify the differences between grade variables corresponding to categorical variables and potential group types according to the experience of ESD. In addition, in relation to the educational

experience of SD, the group with educational experience was set to 1 and the group without educational experience was set to 0. Table 3 shows the study variables selected in this study.

**Table 3.** Independent variables.

Variables	Measurement Variables	
Grade (Variable number of grades, Y1, Y2, Y3 set)	Freshman (1st grade)	1: Y1 = 0, Y2 = 0, Y3 = 0
	Sophomore (2nd grade)	2: Y1 = 1, Y2 = 0, Y3 = 0
	Junior (3rd grade)	3: Y1 = 0, Y2 = 1, Y3 = 0
	Senior (4th grade)	4: Y1 = 0, Y2 = 0, Y3 = 1
Experience of education for sustainable development (ESD)	Exist	Exist: 0
	None	None: 1

### 3.4. Research Models and Analysis

In order to achieve the purpose of this study, the research was conducted in the following procedure. First, in order to derive latent class (research question 1), latent class analysis (LCA) was used. The method proposed by Nylund et al. [44] was applied to extract the model that best describes the target population. As in the Lo-Mendell-Rubin likelihood rate test (LRT; [45]), the method of performing verification of differences between each class model has the advantage of enabling statistically significant distinctions, but it has the disadvantage of having a very long computation process. Therefore, Nylund et al. [44]. Initially judged the basic model fit by comprehensively comparing AIC [46], BIC [47], sample-size adjusted BIC (saBIC), and Entropy value. They suggest that it is efficient to perform LRT verification on several proposed hypothetical models. This study applied this method and used Mplus 7.31 for analysis.

Model fit was determined by applying AIC [46], BIC [47], saBIC, entropy, posterior probabilities. AIC, BIC, and saBIC are more appropriate models with lower values, and the entropy index has a value between 0 and 1, and closer to 1, it can be judged that the lower class of the model are well classified [44,48]. On the other hand, we also considered the number of cases in the lower class included in the model. If the proportion of students in each group, which is the lower class of the model, is classified as less than 1% of the total number of cases, it is difficult to see this as the optimal model. Lastly, as the posterior probability was close to 1, the latent class model was judged to be appropriate. So far, no clear cut-off criteria have been proposed for the goodness-of-fit models presented. Wang and Wang [48] cited Clark [49]'s study and suggested entropy of 0.8 or higher acceptable, and reviewed Nagin [50]'s study and applied 0.7 or higher posterior probabilities to apply the appropriate latent class. Second, a multinomial logistic regression analysis was conducted to find predictors that distinguish each group (Research Question 2). To confirm multicollinearity, correlation analysis was performed and tolerance and VIF values were checked. Specific results are shown in Table 4. Most of the variables showed relatively high correlations at statistically significant levels. Field [51] cited Menard's [52] and Myers's [53] arguments and suggested that multicollinearity can be suspected if tolerance values are less than 0.1 or VIF values are greater than 10. The analysis results show that the tolerance and VIF values of all variables do not violate multicollinearity (Table 4).



**Table 4.** Correlation coefficients among variables and indicators related to multicollinearity.

		Correlation															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1																
2	−0.306 **	1															
3	−0.211 **	0.033 **	1														
4	0.022 **	0.611 **	0.003	1													
5	0.077 **	−0.028 **	−0.007	0.021 **	1												
6	0.048 **	−0.044 **	−0.012 **	−0.016 **	0.052 **	1											
7	0.002	−0.031 **	−0.022 **	−0.035 **	0.054 **	0.009 *	1										
8	−0.035 **	0.124 **	−0.056 **	0.134 **	0.046 **	0.043 **	0.194 **	1									
9	0.028 **	−0.124 **	−0.001	−0.095 **	0.017 **	0.020 **	0.090 **	0.018 **	1								
10	−0.025 **	−0.039 **	−0.006	−0.032 **	0.025 **	0.014 **	0.072 **	0.048 **	0.345 **	1							
11	−0.047 **	0.000	0.020 **	−0.002	−0.022 **	0.007	0.105 **	0.059 **	0.344 **	0.411 **	1						
12	−0.019 **	0.006	−0.001	0.019 **	0.015 **	0.016 **	0.125 **	0.077 **	0.343 **	0.416 **	0.564 **	1					
13	0.070 **	0.073 **	0.035 **	0.076 **	−0.039 **	0.004	0.099 **	0.081 **	0.359 **	0.338 **	0.456 **	0.422 **	1				
14	−0.045 **	0.056 **	−0.030 **	0.060 **	−0.034 **	0.005	0.091 **	0.080 **	0.389 **	0.372 **	0.478 **	0.463 **	0.608 **	1			
15	−0.030 **	0.116 **	−0.008	0.154 **	−0.042 **	0.004	0.091 **	0.108 **	0.239 **	0.309 **	0.412 **	0.394 **	0.576 **	0.613 **	1		
16	−0.034 **	0.176 **	0.036 **	0.201 **	−0.055 **	−0.004	0.068 **	0.102 **	0.224 **	0.311 **	0.421 **	0.388 **	0.397 **	0.353 **	0.390 **	1	
Tolerance	0.795	0.508	0.939	0.550	0.980	0.992	0.940	0.928	0.784	0.709	0.561	0.580	0.451	0.429	0.453	0.760	
VIF	1.257	1.970	1.065	1.891	1.021	1.008	1.064	1.078	1.276	1.410	1.781	1.723	2.220	2.333	2.079	2.209	

\*\*  $p < 0.01$ , \*  $p < 0.05$ .

## 4. Results

### 4.1. Latent Class for Attitudes and Perceptions about Sustainable Development

#### 4.1.1. Model Selection

The model fit was examined by increasing the number of latent classes from two to seven. As the number of latent classes increased, model fit improved (Table 5). SaBIC, on the other hand, decreased as the number of latent classes increased. The entropy value of 0.87 was the closest to 1 in the seventh-classes model with the highest number of latent classes, and was close to 0.8 in the sixth-classes model. Therefore, the six-classes model and the seven-classes model were set as hypothetical models. As a result of the LRT test, the difference between the two models was statistically significant. This means that the seven-classes model explains the collected data better than the six-classes model. However, in the seven-classes model, the number of cases in one latent class was only 1% of the total sample. In this case, there is a problem that it is difficult to guarantee heterogeneity of the class [48].

**Table 5.** Goodness-of-fit analysis of latent class model.

Number of Classes	2 Classes Model	3 Classes Model	4 Classes Model	5 Classes Model	6 Classes Model	7 Classes Model
Log-likelihood	−30,673.413	−30,284.986	−30,154.411	−29,998.782	−29,809.622	−29,704.556
SaBIC	61,363.628	60,591.356	60,334.789	60,028.113	59,654.374	59,448.827
Entropy	0.764	0.796	0.749	0.771	0.776	0.815
LRT	0.000	0.000	0.000	0.003	0.000	0.000
BLRT	0.000	0.000	0.000	0.003	0.000	0.000

saBIC: sample size adjusted Bayesian information criterion, LRT: Lo–Mendell–Rubin test; BLRT: Bootstrapped Likelihood Ratio Test.

Therefore, in this study, we examined the probability of membership by class in order to check the qualitative condition of exclusivity between classes. As a result, all classes met the minimum membership probability of 0.70 as suggested by Nagin [50]. This demonstrates that the probability of belonging to a class of individuals is obvious, and that the class included in the model are heterogeneous.

#### 4.1.2. Characteristics of Latent Classes

The class membership probabilities and the response probabilities for each item according to the 6-classes model are shown in Table 6. When analyzing the probability of membership in each group, 25.8% of the subjects are expected to belong to ‘Class I’, 6.0% to ‘Group II’ and 9.9% to ‘Group III’. In addition, 39.6%, 9.6%, and 9.1% are expected to belong to ‘Class IV’, ‘Class V’, and ‘Class VI’, respectively. The naming was attempted for each class considering the characteristics of the response probabilities for each item according to the class membership.

In terms of awareness and attitudes toward SD, ‘Class I’ showed a higher probability of responding that all four areas of conservation of the natural environment, economic growth, human rights, and social justice, and scientific development are urgently needed for SD. It values the environment over the economy, and does not aim for social welfare ‘by allowing natural causes’ but it is a group that is less likely to respond positively to the view of ‘science can solve environmental problems’ by prioritizing policies for the socially disadvantaged. Collectively, ‘Class I’ was named ‘Ecological centered social welfare’.

‘Class II’ is a group with a high probability of recognizing environmental conservation and scientific development as an urgent task, emphasizing environmental conservation over economic growth, and 100% chance of responding that it can solve environmental problems through science. In addition, there is a 75% probability of responding that ‘Natural damage can be allowed for social welfare’. This was named ‘Techno-centrism centered social welfare’ to reflect these attributes.

**Table 6.** Probability of class membership and item-response for 6-class model.

	Class I	Class II	Class III	Class IV	Class V	Class VI	
Probability of latent class membership within classes	0.269	0.051	0.102	0.391	0.095	0.086	
Item-response probabilities within each class							
Awareness of the conceptual elements of SD	Sustainable development includes 'new science and technology development to reduce environmental pollution'.	0.000	0.779	0.076	0.079	0.943	0.533
	Sustainable development includes 'reacquiring natural resources for human benefit within environmental capacity'.	0.891	1.000	0.102	0.796	0.252	0.136
	Sustainable development includes 'prioritizing nature over human needs in the development process'.	0.430	0.008	0.947	0.000	0.411	0.692
	Sustainable development includes maintaining stable economic growth in the long term'.	0.011	0.199	0.228	0.171	0.912	0.677
	Sustainable development includes 'the importance of local production and local consumption'.	0.483	0.030	0.024	0.064	0.401	0.888
	Sustainable development includes 'help people from poverty, hunger and disease'.	0.350	0.057	0.315	0.018	0.013	0.944
	Sustainable development includes 'social development that recognizes the needs of everyone'.	0.799	0.342	0.709	0.025	0.131	0.267
Attitude toward SD	Conservation of the natural environment is urgently needed for sustainable development.	0.914	1.000	0.427	0.884	0.757	0.702
	The development of basic science is urgently needed for sustainable development.	0.728	0.893	0.094	0.172	1.000	0.752
	Economic growth is urgently needed for sustainable development.	0.972	0.226	0.305	0.245	1.000	0.827
	Human rights and social justice are urgently needed for sustainable development.	0.794	0.125	0.000	0.250	0.623	1.000
	Economic growth must be achieved even if the natural environment is damaged.	0.000	0.000	1.000	0.000	0.338	0.845
	Environmental conservation is more important than economic growth.	0.733	0.834	0.282	0.587	0.000	0.833
	Natural damage can be allowed for social welfare.	0.000	0.758	0.789	0.028	0.445	0.665
	Budget should be allocated first to policies for the socially disadvantaged.	0.798	0.617	0.779	0.664	0.342	0.839
	Science and technology can solve environmental problems.	0.220	1.000	0.658	0.474	1.000	0.598

'Class III' has a 100% chance of responding to economic growth even if the natural environment is damaged, emphasizing economic growth rather than the environment. It is also distinguished from other classes in that the probability of recognizing environmental conservation as an urgent task for SD is relatively low. Reflecting these attributes, 'Class III' was named 'Economic growth based on social welfare'.

'Class IV' recognizes the preservation of the natural environment as an urgent task for SD, and has a negative attitude to 'economic growth must be achieved even if the natural environment is damaged' or 'to undermine the natural environment for social welfare'. Reflecting these characteristics, 'Class IV' was named 'Greenism'.

'Class V' is a group that 100% considers scientific development as an urgent task for SD and believes that science and technology can solve environmental problems. As for the relationship

between the economy and the environment, there was a very low probability of responding that Environmental conservation is more important than economic growth (0%). Although it is lower than the 100% probability of responding to economic growth and scientific development as a task for SD, the probability of selecting natural environment conservation as an urgent task is about 75%. Reflecting these characteristics, 'Class V' was named 'Techno-centrism centered economic growth'.

'Class VI' is a group that has a 100 percent chance of choosing human rights and social justice as an urgent task for SD. Although the probability of affirmative response is relatively low compared to human rights and social justice, it is distinguished from other classes in that it recognizes all areas such as environment, economy, and science as urgent tasks. Moreover, this class is characterized by the recognition that environmental conservation is more important than economic growth, rather than the position that either dimension of the environment or economy is more important, but that natural damage can be allowed for economic growth or social welfare. This class also places great emphasis on the socially underprivileged and has a very high probability of recognizing human rights and social justice as an urgent task. In order to reflect these characteristics, 'Class VI' was named as 'Ecological centered social and economic growth'.

#### 4.2. Multiple Logistic Regression Analysis for Differences in Grades and Sustainable Development Education Experiences

In order to analyze the characteristics of potential groups according to their grades and experiences of ESD, multinomial logistic regression was performed. We set 'Class III' up as the reference group for the analysis, and performed multiple logistic regression analysis with independent variables of grade and SD education experience. Y1, Y3, and educational experience, which are grade variables, were found to have a significant effect on the probability of belonging to a potential group at the  $p < 0.001$  level, respectively (Table 7).

**Table 7.** Logistic regression coefficient ( $\beta$ ) and odds ratio (OR) by variable.

Variables	Class I		Class II		Class III		Class IV		Class V		Class VI	
	$\beta$	OR	$\beta$	OR	$\beta$	OR	$\beta$	OR	$\beta$	OR	$\beta$	OR
Y1 ***	1.13	2.57	0.94	2.52	-	1.00	1.26	3.51	1.09	8.52	-0.41	0.91
Y2	-0.53	0.51	0.19	1.57	-	1.00	-0.35	0.74	1.78	3.36	0.04	1.58
Y3 ***	6.13	357.50	1.68	5.57	-	1.00	5.29	152.86	3.64	969.28	1.41	8.15
Experience of ESD ***	1.68	5.93	0.42	1.52	-	1.00	1.13	5.93	5.97	204.22	0.86	28.14

OR: Odds ratio, -: reference group \*\*\*  $p < 0.001$ .

Comparing the differences according to grade level, the probability that second graders ( $Y1 = 1$ ,  $Y2 = 0$ ,  $Y3 = 0$ ) belong to class I is 2.57 times higher than first graders ( $Y1 = 0$ ,  $Y2 = 0$ ,  $Y3 = 0$ ). The probability of belonging to Class II is 2.52 times, the probability of belonging to Class IV is 3.51 times, and the probability of belonging to class V is 8.52 times higher. On the other hand, the probability of belonging to Class VI is 0.91 times higher for first graders than for second graders. Fourth graders ( $Y1 = 0$ ,  $Y2 = 0$ ,  $Y3 = 1$ ) were more likely to be in each group than in first and second grades in all groups. Compared to the first grade, 357.50 times in Class I, 5.57 times in Class II, 152.86 times in Class IV, 969.28 times in Class V, and 8.15 times in Class VI. Compared with the sophomore year, 139.10 times in Class I, 2.21 times in Class II, 43.54 times in Class IV, 113.76 times in Class V and 8.95 times in Class VI. Compared with the educational experience, the group with experience in ESD at university was 5.93 times for Class I, 1.52 times for Class II, 5.93 times for Class IV, 204.22 times for Class V, Class VI is 1.55 times higher.

Putting the above results together, students in 4th grade are recognized to consider 'environment' rather than 'not considering environment' than those in 1st and 2nd graders, and those with educational experience are not considered 'environmental consideration'. It can be concluded that it is more likely

to belong to a group that understands and to a group that has a view of 'harmony between society and economy based on environment'.

## 5. Discussions

The above results can be examined in line with the types of SD concepts or sub-categories for classifying the types of SD concepts recognized in previous studies. The Class IV can be seen as having a similar attitude to that of the first generation, when the concept of SD was introduced, and the probability of belonging to such a group is about 40%. The perspective of approaching as a combination of 'environmental conservation' and 'economic growth', which is the second-generation view of SD, can be viewed as Class V, and the probability of belonging to this group is about 10%. Groups with attitudes similar to those of the development of environment, economy, and society, which can be regarded as the perspective of the third generation, can be classified as Class VI, and the probability of belonging to this group is about 10%. Unlike attitudes that take environmental considerations, whether technical or ecological, Class III, which does not focus on 'environment', exists as one of the types of perception and there is a probability that 10% belong to this group. These findings are similar to previous studies that have shown that SD has been approached with 'steady economic development and rising incomes [2,3]'. Therefore, the four classes, Classes III, IV, V, and VI, are related to the changing process of SD or the type of perception of the concept of SD established in previous studies. However, Class I and II are groups that look at SD in two dimensions, 'environment' and 'society'. Although the two classes are divided into ecological and technical environmentalist perspectives, they are common in view of SD in two dimensions: Environment and society. From this perspective, the probability of belonging to a class looking at SD is around 31% of all respondents.

Our results show that college students majoring in landscape architecture tend to view the concept of SD from an 'environmental' and 'environmental and economic harmony' point of view rather than from a 'environmental, social, and economic' point of view, in aspects of the two SD models discussed above, our results imply students majoring in landscape are inclined to the concentric circle model. The concentric circles model should be interpreted in terms of emphasizing that maintaining a sustainable natural environment is a fundamental goal, rather than implying that the goals emphasized in the three areas of environment, economy and society cannot be achieved simultaneously [12]. In-depth discussions should be made as to which of these two perspectives is more realistic and meaningful for SD. In previous studies [2,3], the concept of SD was categorized as 'social development within the limits of the global ecosystem'. It can be interpreted in a position similar to that of the model of Figure 1b. This is an expression of a willingness to improve the quality of life for current and future generations by harmonizing environmental conservation with economic and social development [14,17,54,55].

In terms of experience of ESD, the group with experience in ESD was 28% more likely to be in Class VI (Greenism) than the group without education. This is hopeful in view of the possibility of perception change through ESD. It is important to note, however, that it was 204 times higher than Class V (Techno-centrism centered economic growth). In other words, it is possible to assume that ESD was approached from the perspective of a 'harmonious harmony between environment and economy.' Also, given the findings of the students' various attitude about the future of society, there is a pressing need to develop curriculum that will empower each student to act as an agent of change in their own lives and communities as well as in their future careers. While it is important to increase students' multidisciplinary knowledge of SD, simply accumulating it is not enough.

Comparing the differences between grades, students in 4th grade were more likely to be in Class V than students in grades one and two. This assumes the possibility that the curriculum of the landscape architecture department emphasizes the perspective of 'harmonization of environment and economic growth through a technological approach'. This may be natural phenomenon in light of the academic trait of the science-based field, which emphasizes changes through development of technology. However, if the Class V (Techno-centrism centered economic growth) is pursued without

consideration for the socially underprivileged or without consideration of human rights, it may lead to discomfort among the classes and may face limitations in facilitating a sustainable society. In particular, science and technology alone cannot solve all problems, and it is necessary to recognize the possibility that scientific knowledge may not be incomplete or decisive. As a way to raise awareness, we suggest developing curriculum for organizing interdisciplinary courses to comprehensively access the 'environmental, social and economic' areas for the 1st and 2nd grade student. For students in 3rd grade, they stayed in transition to fourth grade, showing no significant change in attitude. In this case, the curriculum that focuses on the design studio based on the first and second grade courses would be helpful.

## 6. Conclusions

Reflecting the interest in SD, researches on the attitude toward SD have been steadily conducted for various groups such as preservice teachers, in-service teachers, university students, civil servants, and citizens. However, few studies have examined the awareness and attitudes toward SD among college students majoring in landscape architecture, who may be preliminary experts in various environmental industries or environmental policy-related fields. Thus, this study examined the types of awareness and attitude towards SD among college students majoring in landscape architecture and analyzed whether there is a difference in the perception type of SD according to educational experience and grade. For this purpose, the LCA was used to identify the combination of relationships found in the classes based on similar patterns among the characteristics of people rather than the relationship between observation variables. The results of this study are as follows.

First, six latent classes were extracted in relation to attitudes toward SD. Six classes have been found that overlap with the types of perceptions that have been formed by changing to 'environmental protection', 'environmental and economic harmony', and 'environmental, economic, and social development'. There were also classes of attitudes that approached from an economic perspective. As such, they were consistent with the concepts proposed in the process of SD or the items that previous researchers classified as the concept of SD. However, classes that understand SD were also extracted from the perspective of 'environmental conservation and social welfare', which was not presented as an item in previous studies. Second, it has been revealed that college students majoring in landscape architecture tend to view the concept of SD from an 'environmental' and 'environmental and economic harmony' point of view rather than from a 'environmental, social, and economic' point of view. Third, grades and educational experiences were found to have a significant effect on the probability of belonging to a specific latent class for SD.

This study has an implication that it understands the different types of perception of college students majoring in landscape architecture with regard to SD. In addition, highlighting the importance of ESD implementation, this study also provides basic data suggesting the need to recognize the importance of a discussion of what needs to be addressed in the process. However, this study has limitations in generalizing the results in that the relationship between the domains is measured by one or two items and the use of convenience sampling. For the future references, standardized test tools that can further analyze the dynamic aspects of SD should be developed and surveyed based on probability sampling. In addition to the analysis of attitude differences according to the presence or absence of the experience of ESD, the research on the differences in attitude of ESD itself should also follow. These studies can better explain the differences according to the distribution of groups, and can be more practical help in organizing the curriculum for department of landscape architecture.

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