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From Uniformity to Sustainable Diversity: Exploring the Design Attributes of Renovating Standardized Classrooms in Korea

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Abstract: Modern school buildings in South Korea, which were until the 1990s typically designed with standardized and monotonous features based on drawings provided by the government, are shifting to more well-designed spaces under a student-centered approach in this more creative and imaginative era. The purpose of this study is to examine the renovation priorities of design features based on the preferences of architects and educators, paying particular attention to classroom design for enhancing students' spatial and aesthetic experiences. For this unusual approach, architects and school educator groups, who jointly plan the renovation of traditional classrooms, were surveyed on classroom design features and the spatial and aesthetic experiences of students. Forty-nine responses were analyzed using an importance–satisfaction analysis (ISA). The gap analysis for all respondents showed significant differences—a significance level of 0.05 between importance and satisfaction—in 31 design attributes in traditional and standardized classrooms. Both the architects and the school educator groups designated five attributes as being of the highest priority for the classroom renovations: ventilation, overall classroom shape, shape of furniture, floor material, and furniture material. Results of these analyses could become considerations for future classroom renovations by local governments to enhance educational environments. In addition, policy recommendations for applying the results of this study to be sustainable classroom renovation throughout South Korea could be an important topic of discussion.

Keywords: classroom design; school design; classroom renovation; indoor school environments; importance–satisfaction analysis

1. Introduction

An increased understanding of the influence of physical learning environments on students has drawn global attention, prompting a reconsideration of the design of school spaces to support various teaching and learning styles [1]. In South Korea, the movement to renovate old-fashioned schools (Figures 1,2) is occurring because of a student-centered approach in the current era of creativity and imagination. New approaches and recent empirical evidence on the influence of the physical learning space in school also seem to have contributed to the movement. For example, the space can affect students' motivation, learning progress, performance, emotions, and achievement [2–7]. In addition, school space defines a child's sense of the world. More so than adults, students' strong affective sense of the world around them means they are engaged with places and spaces in schools and become attached to a place or space through their senses and feelings [8]. A well-designed school space for students can lead to connections between students and objects that stimulate feelings and imagination [8].

In South Korea, a conspicuous movement in education has been the renovation of classrooms in old school buildings by local governments. Contemporary public school buildings of all levels in Korea were built by adapting standardized drawings provided by the government, initially published in 1962, to deal with the explosive population growth from the 1950s to the early 1980s [9] after the Korean War. The standard school design has been adapted as the traditional model to manage large student bodies effectively and reduce construction costs (Figures 1,2). These standard drawings used to include guidelines for school design from macroscopic aspects to make a standardization of materials and construction methods (such as building size, materials, module of plan, floor height, and size of classrooms and windows) to rather specific standards. There are no standards described for specific interior design attributes. The standard drawings included floor plans, elevations, sections, and structural drawings. It prioritized design as a simple, clear structure and form that could be applied anywhere. [10]. In point of fact, the revised version gave streamlined standards for school architectures than the previous version, leaving out specifications on architectural attributes of school buildings as educational spaces [9]. Yet, the standardized approach of designing school buildings brought many issues including imbalance of daylight distribution, discomfort glare, over heating near windows, poor ventilation and quality, and difficulty of indoor temperature control [10]. Until 1992, while the drawings were being adapted in 82 pilot schools of the government's school modernization plan, it merely updated or added additional floor plans to make it near perfect. To complement the standard drawings, government provided a recommendation through two policy studies: Modernization of School Facilities (1987) and the Study of an Architectural Plan Model for Elementary School (1990). This recommendation eventually led to the renovation of new school buildings to consider design attributes, but they did not thoughtfully reflect natural and architectural attributes of the school building as an educational space (i.e., accomplishing student-centered curriculum and students' spatial and aesthetic experiences). However, the national law regarding the standards of school buildings, "Decree on Standards for School Facilities and Equipment", was abolished in 1997. Still, local government of education offices tend to provide the standards for materials, construction methods, and other details of school buildings. Recently, the nationwide modernization and renovation of school spaces based on the paradigm shift from a standard teacher-centered approach to student-centered education have led to greater user participation and creativity in the design process since the 2000s. The movement toward improving school environments made it possible to incorporate creative ideas into school designs from architecture professionals interested in the design of educational spaces. Further, there is a growing interest in improving the classroom environment to be a more creative space in which children can be motivated and challenged through the diverse consideration of the current school space. To create sustainable space, it is necessary to consider the environmental, social, and economic elements of the space. The elements of school space can significantly influence student cognitive and emotional development through diverse designs that consider development instead of the uniformed design that originated from the economic approach. The sustainable diversity of school building designs can ensure adaptability and flexibility corresponding to changes in the educational environment and user-centered needs for future generations.

(**a**) Standardized school building and classroom arrangement in 1975 [9]

(**b**) School building in 2019

Figure 1. Traditional school and classroom space in South Korea.

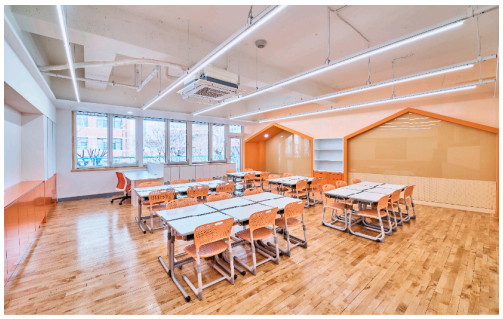
Figure 2. Typical classroom built in South Korea using the standardized drawings.

School environments in South Korea are also facing an unwanted social phenomenon, the decrease of the school-aged population. This lack of students has raised questions about the operation of schools, based on a financial or administrative perspective, and has led to various changes, such as consolidations or closures, or the renovation of school buildings. Local governments in Korea regulate classroom quotas, such as 25 students per classroom, depending on the local government regulation. The decrease in the number of classroom students in Korea has been occurring slowly over the last 20 years. By school level in 2018, there were 22.9 elementary students per classroom (32.8 in 2005), 24.4 middle school students (35 in 2005), and 26.8 high school students (33.6 in 2005), according to data from Seoul Open Data Square (http://data.seoul.go.kr/). However, this decrease offers more space for each student in the classroom, creates additional opportunities to experience new pedagogical approaches in the larger space, and has enlivened students' spatial and aesthetic experiences in school. The renovation of the old type of school building, with its monotonously designed classrooms, halls, and special spaces, is happening because of the need for positive spatial and aesthetic experiences to produce creative students.

Recently, local governments in Korea are actively investing in renovating classrooms in traditional schools based on new design approaches that focus on educational needs, such as the Dream Classroom Project from the Seoul Metropolitan Office of Education and the Renovation Project for Future Education from the Daegu Metropolitan City Government. The projects have triggered a national movement of renovating old schools, and the Ministry of Education plans to invest about 18 billion dollars on the renovation and construction of 1250 schools up until 2023 [11]. The locally administered renovation projects for school classrooms are directed by architects hired by the local government. The architects lead the renovation after examining the schools' needs. The key concepts of the renovation are decided by people in the schools under the basic direction of the local government, such as space for the development of students' creative and emotional sensitivity or future education. The present study is focused on the Dream Classroom Project from the Seoul Metropolitan Office of Education, which actively pursues the expansion and promotion of students' positive spatial and aesthetic experiences through classroom renovation. The concept of classroom

interior design is to renovate classrooms in a fashion appropriate to students' spatial and aesthetic sensibilities to encourage creative experiences and behaviors. However, the renovation designs tend to take far less consideration of pedagogical issues such as learning outcomes or educational effects arising from classroom improvements. Architects involved in classroom renovation have perspectives that differ from those of school educators (principals and teachers) about designs that prioritize easier school management, a more convenient design for giving instruction, ways to monitor students more efficiently, ways to focus students' attention, and a greater alignment between national curriculum and educational environments.

The purpose of this study is to investigate architects' and educators' preferences in the classroom design of Korean schools to augment students' spatial and aesthetic experiences in an era of creative learning and innovation. Through this study, we suggest attributes in classroom designs that will help students enhance such experiences in both existing and newly renovated classrooms.



(a) Seoul Jangan elementary school.

(b) Seoul Sindaerim elementary school (Permitted from Jaewon Choi, Architect).

(c) Seoul Dongdap elementary school (From the Dream Classroom Project).

(d) Seoul Songjeong elementary school.

Figure 3. Traditional renovated classrooms in Korea.

2. Student Experiences and Classroom Design

Recent studies of the classroom as an environment that can inspire certain types of behavior in humans have taken naturalness, individualization, and an appropriate level of stimulation into consideration [3,12]. The interrelationship between the design elements of physical spaces and the human cognitive process has recently had an influence on the designing of educational environments. The interior design of educational spaces has become more attractive, influencing the learning climate and learning results in multiple ways [13]. The physical environment in schools, including design and layout, affects students' attitudes and learning outcomes in various ways, such as a general sense of satisfaction [4], the motivation to actively participate in academic activities [2], learning progress [3,5], and learning achievement [6,7].

Classroom environments can also provide spatial and aesthetic experiences to stimulate students' creativity. The role of students' experiences in improving their creative behavior and thinking are gaining importance in analyses of the classroom environment [14,15]. Studies have found that the physical school environment can stimulate students' imagination and creativity [16]. Elements of physical environments for fostering creativity include furniture, indoor plants or flowers,

colors, windows with views on nature, good lighting (especially daylight), positive sounds, and nice smells [17]. Students inhabiting such a space are able to link the space with their creative behaviors, including the ability to detect patterns, combine unrelated ideas into new ones, and create artistic works [18], because the design elements in the school can enhance students' aesthetic sensibilities through the fusion of thought and feeling [19]. Such sensibilities are important for enhancing students' imagination and colorful thinking in the classroom, which then influences students' innovative possibilities [20]. It is therefore important to add provocative elements of aesthetic experience in classrooms to enhance students' learning, growth, creative expression, and thinking.

However, the connections between design and students' aesthetic experiences in the classroom environment have been discussed relatively less often than other student outcomes, such as learning progress and achievement. Groves and Marlow [21] emphasize the importance of aesthetic experiences for creativity using four types of space that support creative activity: (1) space for stimulation and inspiration, which supports non-verbal means, reinforcing messages, attitudes, and values in the stimulating space; (2) space for reflection and thinking, which allows people to refresh and recharge, providing opportunities for individual contemplation and incubating problems; (3) space for sharing and collaboration, which encourages the sharing of information and knowledge in a non-hierarchical way as well as engineering collisions, accommodating impromptu get-togethers, sharing thinking, and cross-functions; and (4) space for playing, connecting, and exploring, which allows people to attempt deep exploration and experimentation as well as to build relationships without stress.

It is necessary to develop a sense of enriching aesthetic attributes in an educational context. Klein and Kiker [22] envision "architects in the construction of spaces that can promote more humane, thoughtful, and aesthetic leading" (p. 99). The components of classroom design can build a learning space of aesthetic experience for establishing an aesthetically pleasing, home-like environment [23]. Research suggests that in the principles of design and the qualities of educational spaces, the contexts that need to be considered [24] include lighting, color, textures, sound, shape, materials, and patterns for the physical learning environment [3,5,24].

3. Design Attributes for Classroom Renovation

In the present study, we investigated architects' and educators' perceptions of spatial and aesthetic design attributes based on a conceptual framework. The framework shows the effect of classroom environments on students' educational changes after experiencing the spatial and aesthetic aspects of natural and architectural attributes in the classroom (Figure 4).

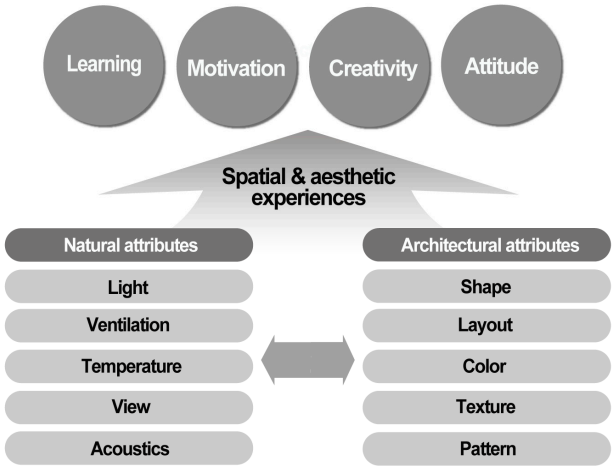


Figure 4. The conceptual framework of classroom design and student development.

In the framework, there are two types of interconnected attributes in designing classrooms to enhance spatial and aesthetic experiences: natural attributes and architectural attributes. Natural

attributes include light, ventilation, temperature, views, and acoustics in the classroom. Lighting in classrooms is important to provide visual comfort for both teacher and student [25]. Visual comfort in the classroom is known as a critical factor in the teaching and learning process [26]; classroom light, including natural light and artificial light, can change students' behavior depending on the lighting regime. For example, reduced brightness produces relaxed students who are interested in classroom activities [27]. Natural light is an important attribute in children's physical development [28]. Lighting can also influence student learning; for example, full-spectrum fluorescent lighting can benefit learning [29], and daylight helps students learn and retain information better [30].

Ventilation is a sustainable way to maintain student health and a thermally comfortable environment; students who spend a large amount of their time in the classroom are more vulnerable than adults to the adverse effects of indoor pollutants [31].

Indoor temperature in the classroom is a known important attribute related to student's learning, with both long-term and short-term consequences for the learning process [32]. Students perform better in a temperature-regulated classroom. There is evidence of a link between students' ethnic backgrounds and the preferred temperature while learning [33].

Classroom windows with attractive views provide students with visual interest and a sense of the outside, helping them understand climate patterns, natural cycles, and different times of the year [34], while good acoustics are known to influence teaching and learning in a classroom through decreasing noise pollution and enhancing speech clarity [35].

Architectural attributes include form, layout, color, texture, and pattern. In Korea, a standardized school design was enacted in 1962, being (among other reasons) effective because it makes school management convenient and keeps construction expenses low [9]. For example, the classroom shape, particularly in 1962 and 1975, therefore, was until recently, considered unchangeable; the classroom module (9 × 7.3 or 7.5 meters), classroom area (65.7 or 67.5 m^2), height of the story (3.15 or 3.3 meters), and width of the corridor (2.4 or 2.5 meters) were all standardized. In particular, the standardized drawings directed the maximum size for external windows, using the entire external wall, except for pillars, beams, and the bottom wall of the window.

Classroom layout consists of the sub-architectural apparatus in the space, which includes the arrangement of tables and chairs, light sources, and so on [36]. Classroom layout tends to be determined by the teacher's pedagogical choice of a learning paradigm, such as teacher-centered vs. student-centered, knowledge transfer focused vs. creative activity focused, and other instructional approaches [36]. Physical classroom layout has been shown to affect children's behavior in the classroom. For example, aggression and destructive behavior increase as the number of children in the classroom increases [37]. In such high-density classrooms, children tend to experience excessive levels of stimulation, stress, and arousal, reductions in desired privacy levels, and loss of control [38]. A semi-circular seating arrangement for students produces a higher level of question-asking compared with row-and-column arrangements [39], while school buildings and classrooms that utilize freely moving spaces help stimulate children's imagination [40] and achievement [6].

Color is a powerful attribute in classroom design, influencing the ambiance of the classroom space [41]. Students note the colors of tables, chairs, walls, furniture, and even the light that surrounds them. Color in the classroom is widely accepted as stimulating children's brains and affecting their emotional responses, mental clarity, energy levels, aesthetic judgments, and performance in cognitive tasks [42–45]. For example, research on color has shown that saturated and warm colors can increase pleasure and excitement, while cold colors produce less active emotions, and natural colors create a relaxed atmosphere [46,47]. In Korea, classroom walls and ceilings are typically white, while the floor and tables are wood-colored.

Texture and patterns in the furniture, wall, floor, ceiling, and cabinetry can create visual stimulation in the classroom environment. People perceive two styles of environment: natural elements, and obtrusive, manufactured elements [48]. People tend to respond to texture as well in their desire to create diversity or unity through manufactured features [49]. Texture can animate landscapes, and children can connect what they see with their sense of touch. Textures of materials, views, and spaces in the classroom environment are important to stimulate children's sensations and

their arousal system [50]. Children need to experience greater varieties of texture in their lives, and the use of textures and patterns in the classroom can increase learning and create a more positive aesthetic experience [3].

5. Methods

1.5.1. Study Sample and Data Collection

Demographic characteristics were collected from a sample of architects and elementary school teachers who were about to participate in classroom renovation in Seoul, Korea. A total of 49 participants (32.05% male) returned the questionnaire with valid responses. Of the respondents, 59.2% (n = 29) were school educators and 40.8% (n = 20) were architects, and by age 7.6% of the respondents were aged below 30 years, 17.0% between 31 to 35, 15.1% between 36.40, 39.6% between 41 to 45, 7.6% between 46 to 50, and 7.54% of the respondents were aged above 51 years old. Between April and June 2018, a questionnaire on classroom interior design was developed and sent to architects and school educators who planned to remodel their school classrooms. The questionnaire consisted of two sections: the perceived importance of and satisfaction with classroom interior design to improve students' spatial and aesthetic experiences, and background information. Of a total of 53 respondents selected, 49 completed valid questionnaires. The Cronbach's alpha value for the reliability analysis (0.96 for the satisfaction items and 0.97 for the performance items) is reliable (above 0.70).

1.5.2. Importance–Satisfaction Analysis

Importance–satisfaction analysis (ISA) is a popular and useful tool for examining people's satisfaction with and expectations of products [51]. ISA, as a multi-attribute model, was developed by Martilla and James [52] to identify and analyze critical satisfaction attributes for products. The underlying assumption of ISA is that people's level of satisfaction with its attributes is derived from their expectations and their judgment of the product's or service's performance [51]. This method can help educators and architects in diagnosing underlying deficiencies and considering priorities in classroom design for a positive spatial and aesthetic experience. ISA is categorized into quality attributes in an ISA grid (see Figure 5) and can analyze the results to improve the targeted program and help the organization improve its service and increase people's satisfaction [53]. This mapping of attributes allows for easier prioritization of interventions based on each attribute's relative performance and its importance to users. The quadrants were constructed based on mean splits [54].

The importance–satisfaction analysis method was used to conduct a correspondence analysis of factors that affect spatial and aesthetic experiences in the classroom. The means of the importance of and satisfaction with current classroom design were used to divide the two-dimensional matrix into four quadrants, as shown in Figure 5. For an ISA grid analysis of the importance of and satisfaction with classroom design in enhancing spatial and aesthetic experiences, satisfaction with 31 items of classroom design was placed on the x-axis, and their importance was placed on the y-axis. Coordinates (x, y) for each item were marked with a dot, and the mean value of importance was set as a reference value of the y-axis while that of satisfaction was set as a reference value on the x-axis for arranging them into two groups, low and high scores. The definitions for the four quadrants are as follows [51,52]:

- Quadrant I indicates high importance and high satisfaction, and attributes that fall within this quadrant are perceived as being very important to respondents and need to be maintained for the current high levels of satisfaction with these activities or services. The message here is "keep up the good work".
- Quadrant II indicates high importance and low satisfaction, and attributes that fall within this quadrant are perceived as being very important to respondents, but satisfaction levels are fairly low. The message here is "concentrate here".

- Quadrant III indicates low importance and low satisfaction, and attributes that fall within this quadrant are perceived as being of little concern. The message here is "low priority".
- Quadrant IV indicates attributes with low importance but high satisfaction. Respondents are satisfied with the attributes but consider present work on the attributes of this quadrant as being unnecessary. This message here is "possible overkill".

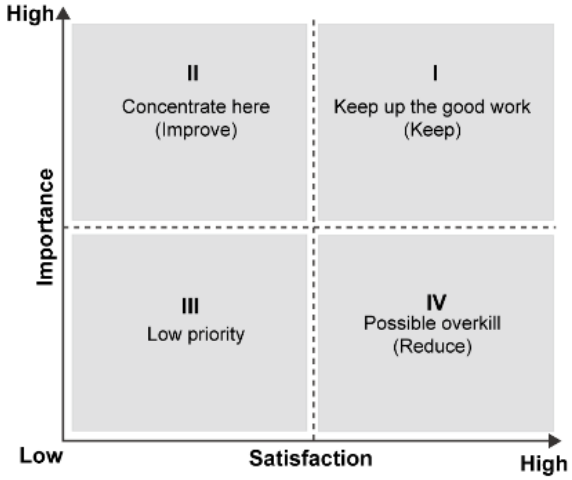


Figure 5. Two-dimensional importance–satisfaction analysis (ISA) matrix [53].

1.5.3. Data Analysis

Data were analyzed in four steps. First, a gap analysis was performed using a pairwise *t*-test to examine the extent to which both group respondents' perceptions of importance and satisfaction matched one another. Second, an ISA was conducted with design attributes being graphically displayed on the importance–satisfaction matrix. To construct the importance–satisfaction matrix, the mean of the values was calculated. In the analysis, importance equals the cumulative percentage of occurrence in the overall sample, and satisfaction was measured using the respondents' perception. Data were classified into four quadrants and placed on a matrix in a counter-clockwise direction. The ISA diagrams were generated using IBM SPSS (version 25) statistical software (Figures 7–9), while Microsoft Excel was used for the gap analysis (Figure 6). Third, an ISA was also conducted to compare school educators and architects. The results of this ISA were used to reorganize each quadrant's attributes into those that were common and those that were different.

6. Findings

1.6.1. Gap Analysis

Table 1 shows the mean values for satisfaction and importance, gap values between satisfaction and importance, paired *t*-tests, and *p*-values. The total mean values for importance and satisfaction were 3.84 and 4.08, respectively. "Ceiling height" had the highest rating on satisfaction (M = 3.47), while the attribute "natural ventilation" was rated the highest in importance (M = 4.55). In contrast, "natural ventilation" was rated the lowest on satisfaction (M = 2.30), and "pattern of ceiling" was rated lowest in importance (M = 3.58). For the satisfaction ratings of 31 attributes, the gaps between the means of the importance and the satisfaction ratings are calculated and presented in Table 1 and Figure 2. Lai and Hitchcock's (2015) *t*-test was used to compare the ratings between the importance and the satisfaction level in the ISA methodology. All 31 attributes show significant differences, and their *p*-values are presented in Table 1. All *t*-tests showed significant differences, with 31 items significantly lower in satisfaction than in importance. Figure 6 shows their importance, satisfaction, and the gap between them.

1.6.2. Importance–Satisfaction Analysis

The importance and satisfaction scores for each individual attribute were used to produce an ISA matrix. The satisfaction and importance data presented in Table 1 were used to map the attributes into one of four groups depending on their satisfaction with and importance for classroom design for enhancing students' aesthetic experiences. A mean split was used to distinguish between the high and low categories in each quadrant.

The means for overall importance and satisfaction are the cut-off points between ISA quadrants [55]. The means of the importance and satisfaction ratings of every attribute were compared to the overall importance rating mean (M = 4.08) and overall satisfaction rating mean (M = 2.84) of the respondents, and an ISA graph is shown in Figure 7, where the two lines representing attribute importance and attribute satisfaction were aligned, but the gaps between satisfaction and importance were identified in most of the attributes.

In Quadrant I (Q1), attributes had a higher-than-average rating in both importance and satisfaction. Seven attributes were in the first quadrant, "keep up the good work". These seven attributes comprised Quadrant I: (1), natural light; (5), artificial lighting; (8), the shape of floor; (17), arrangement of lighting fixtures; (18), window arrangement; (24), floor color; and (25), wall color. This result indicates a match between importance and satisfaction. Four attributes (1, 5, 17, and 18) had a relatively high satisfaction value (above 3.0). The satisfaction values of the other three attributes (8, 24, and 25) were all less than 3.0, ranging from 2.88 to 2.92. All attributes in the Quadrant I should strive to maintain and improve classroom design in terms of these seven attributes so that they could eventually have a high satisfaction value. Interestingly, the attribute natural light (1) was ranked as most important (M = 4.51), while window arrangement (18) was the highest attribute in satisfaction (M = 3.14) in Quadrant I. Respondents perceived this attribute to be the most important and highest in terms of satisfaction with classrooms' spatial and aesthetic potential.

In Quadrant II, attributes had a lower-than-average rating in satisfaction but a higher-than-average rating in importance. These attributes were important but were less satisfying, indicating room for improvement. Of these 31 items, nine items fall into the second quadrant of ISA. These nine attributes were (2), acoustical environment; (3), natural ventilation; (6), indoor temperature; (7), overall classroom shape; (11), shape of furniture; (12), shape of windows; (13), shape of lighting fixtures; (20), floor material; and (23), furniture material. The *t*-test results also show that the gaps between importance and satisfaction for these nine items were statistically significant, and they should be prioritized [56].

In Quadrant III, attributes had a lower-than-average rating in both importance and satisfaction. Six attributes in the quadrant indicate "low priority": (9), the shape of wall; (10), shape of ceiling; (14), furniture size; (21), wall material; (22), ceiling material; and (31), furniture pattern.

In Quadrant IV, attributes had a higher-than-average rating in satisfaction but a lower-than-average rating in importance, indicating "possible overkill." These nine attributes were: (4), window view; (15), window size; (16), ceiling height; (19), furniture arrangement; (26), ceiling color; (27), furniture color; (28), floor pattern; (29), wall pattern; and (30), ceiling pattern. They were perceived as satisfying but not important, and therefore architects and educators should not focus on these attributes as redesigning them would result in "possible overkill".

Table 1. Importance–satisfaction analysis (ISA) results, including mean, gap, and paired *t*-tests for mean differences.

Attribute	Total respondents					School Educators			Architects		
	Mean		Gap	*t*	Q	Mean		Q	Mean		Q
	S	I	(S–I)			S	I		S	I	
1. Natural light	3.14	4.51	–1.37	–7.62***	1	3.41	4.52	1	2.89	4.45	1
2. Acoustical Environment	2.78	4.16	–1.38	–7.36***	2	2.76	4.41	2	2.79	3.95	4
3. Natural ventilation	2.30	4.55	–2.25	–11.50***	2	2.17	4.63	2	2.58	4.40	2
4. Window views on nature	3.08	3.92	–0.84	–4.62***	4	3.21	3.96	4	2.89	3.90	4
5. Artificial lighting	3.14	4.37	–1.23	–6.61***	1	3.66	4.30	1	2.42	4.45	2
6. Indoor temperature	2.80	4.27	–1.47	–8.63***	2	2.86	4.41	2	2.79	4.05	1
7. Overall classroom shape	2.68	4.20	–1.52	–8.33***	2	2.83	4.41	2	2.47	4.00	2
8. Shape of floor	2.88	4.16	–1.28	–6.58***	1	3.03	4.52	2	2.58	3.75	3
9. Shape of walls	2.54	4.06	–1.52	–8.61***	3	2.59	4.22	2	2.53	3.90	3
10. Ceiling shape	2.62	3.88	–1.26	–6.61***	3	2.83	4.04	3	2.32	3.65	3
11. Shape of furniture	2.34	4.31	–1.97	–11.27***	2	2.45	4.33	2	2.26	4.25	2
12. Shape of windows	2.78	4.16	–1.38	–7.28***	2	3.10	4.26	1	2.42	4.10	2
13. Lighting fixtures	2.76	4.18	–1.42	–7.61***	2	3.10	4.44	1	2.37	3.90	3
14. Furniture size	2.82	4.02	–1.20	–6.74***	3	2.86	4.07	3	2.74	4.00	1
15. Window size	3.06	4.02	–0.96	–5.42***	4	3.34	4.15	4	2.74	3.85	4
16. Ceiling height	3.47	3.94	–0.47	–2.93**	4	3.76	3.89	4	3.20	4.05	2
17. Arrangement of lighting fixtures	3.00	4.13	–1.13	–7.17***	1	3.41	4.18	4	2.60	4.10	1
18. Window arrangement	3.17	4.10	–0.93	–6.13***	1	3.55	4.18	4	2.80	4.00	1
19. Furniture arrangement	2.87	4.06	–1.19	–7.46***	4	3.07	4.11	4	2.70	4.00	1
20. Floor material	2.75	4.25	–1.50	–8.07***	2	2.93	4.43	2	2.55	4.10	2
21. Wall material	2.57	4.04	–1.47	–8.52***	3	2.72	4.18	3	2.40	3.90	3
22. Ceiling material	2.68	3.83	–1.15	–6.12***	3	2.83	4.14	3	2.50	3.50	3
23. Furniture material	2.57	4.13	–1.57	–9.43***	2	2.72	4.21	2	2.35	4.05	2
24. Floor color	2.92	4.08	–1.15	–6.50***	1	3.34	4.21	1	2.55	4.00	2
25. Wall color	2.91	4.13	–1.23	–7.23***	1	3.31	4.18	4	2.45	4.20	2
26. Ceiling color	2.98	3.85	–0.87	–4.55***	4	3.41	3.96	4	2.55	3.90	3
27. Furniture color	2.87	4.08	–1.21	–6.96***	1	3.38	4.14	4	2.25	4.10	2
28. Floor pattern	3.06	3.73	–0.67	–3.80***	4	3.34	3.96	4	2.65	3.60	4
29. Wall pattern	2.89	3.79	–0.90	–5.12***	4	3.10	3.89	4	2.60	3.75	4
30. Ceiling pattern	2.87	3.58	–0.71	–3.87***	4	3.10	3.71	4	2.60	3.50	4
31. Furniture pattern	2.79	3.83	–1.03	–5.87***	3	2.97	3.93	3	2.55	3.80	3
Total mean	2.84	4.08				3.07	4.19		2.58	3.97	

Note: I = Importance, S = Satisfaction, Q = Quadrant.

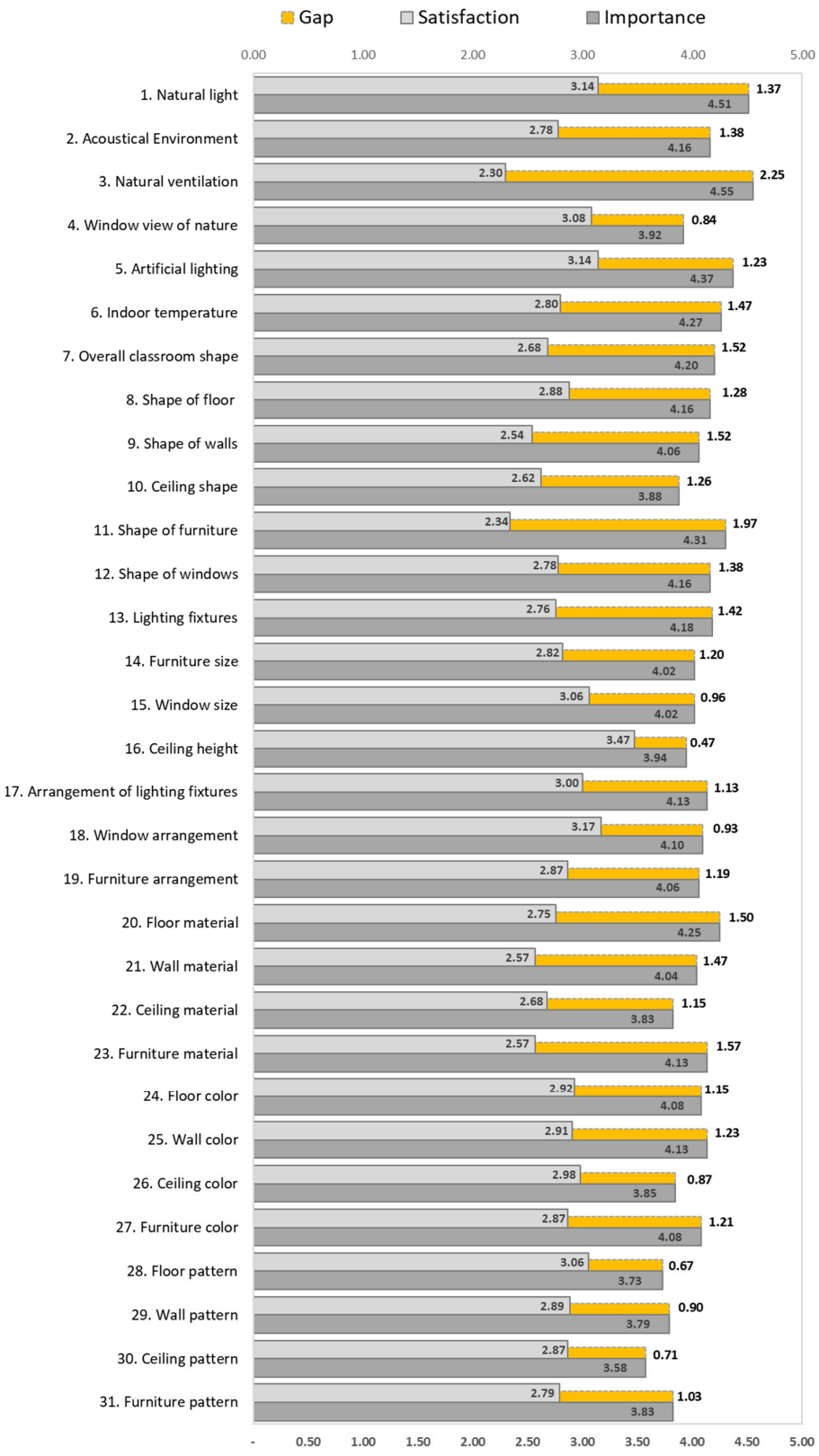


Figure 6. Importance and satisfaction ratings from participants.

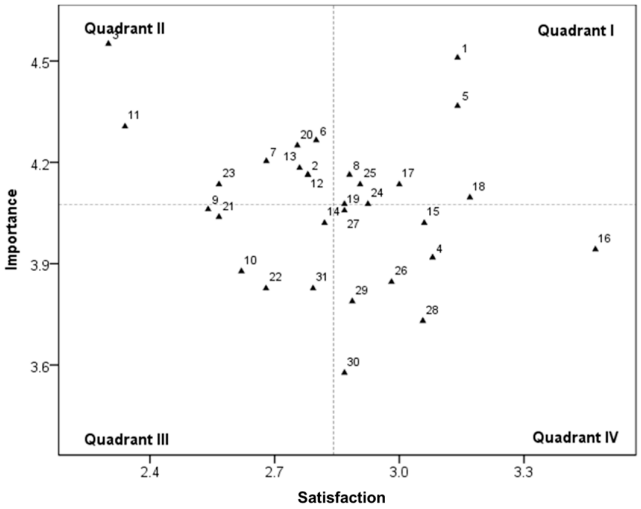


Figure 7. ISA grid for all respondents.

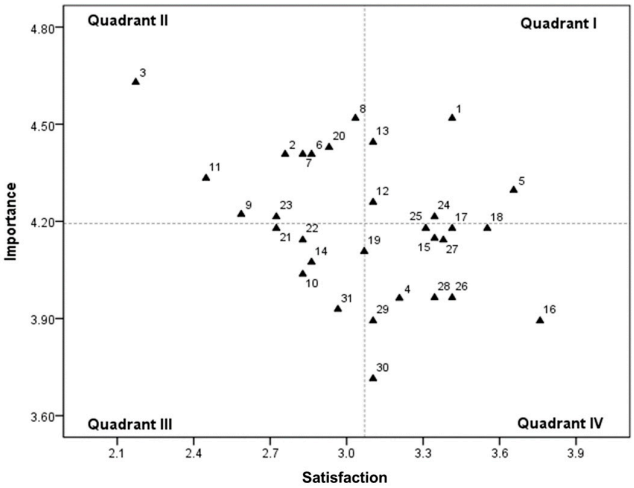


Figure 8. ISA grid for school educators.

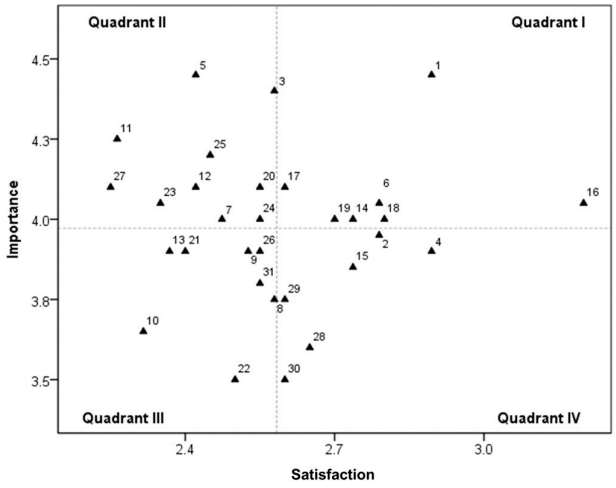


Figure 9. School architect ISA results.

1.6.3. Comparison Between School Educators and Architects in the ISA

Table 2 and Figures 8 and 9 show how school educators and architects perceived importance and satisfaction. For school educators, *t*-tests show that 31 pairs were significantly different, with most attributes' values being lower in satisfaction than in importance. Also, architects showed extremely similar results to educators, which shows that *t*-tests for all attributes were significantly different on importance and satisfaction.

In Quadrant I, the two groups shared only one attribute higher than the overall average rating in both importance and satisfaction, (1), natural light. In Quadrant II, five attributes have lower-than-average ratings in satisfaction, but higher-than-average ratings in importance. These five attributes were shared in the second quadrant: (3), natural ventilation; (7), overall classroom shape; (11), the shape of furniture; (20), floor material; and (23), furniture material. However, educators show different responses for the acoustical environment (2), indoor temperature (6), shape of floor (6), and shape of walls (9).

In Quadrant III, both groups share four attributes with a lower-than-average rating in both importance and satisfaction: (10), shape of ceiling; (21), wall material; (22), ceiling material; and (31), furniture pattern.

In Quadrant IV, both groups share five attributes with a higher-than-average rating in satisfaction, but lower-than-average rating in importance: (4), window views on nature; (15), window size; (28), floor pattern; (29), wall pattern; and (30), ceiling pattern.

Table 2. Attributes of renovating classroom design by ISA results.

ISA Matrix	Total	Common attributes	
		School educators' attributes	**Architects' attributes**
Quadrant I (Keep up the good work)	1. Natural light 5. Artificial light 8. Shape of floor 17. Arrangement of lighting fixtures 18. Window arrangement 24. Floor color 25. Wall color 27. Furniture color	1. Natural light	
		5. Artificial lighting 12. Shape of windows 13. Shape of lighting fixtures 24. Floor color	6. Indoor temperature 14. Furniture size 17. Arrangement of lighting fixtures 18. Windows arrangement 19. Furniture arrangement
Quadrant II (Concentrate here)	2. Acoustical environment 3. Natural ventilation 6. Indoor temperature 7. Overall classroom shape 11. Shape of furniture 12. Shape of windows 13. Shape of lighting fixtures 20. Floor material 23. Furniture material	3. Natural ventilation 7. Overall classroom shape 11. Shape of furniture 20. Floor material 23. Furniture material	
		2. Acoustical environment 6. Indoor temperature 8. Shape of floor 9. Shape of walls	5. Artificial lighting 12. Shape of windows 16. Ceiling height 24. Floor color 25. Wall color 27. Furniture color
Quadrant III (Low priority)	9. Shape of walls 10. Shape of ceiling 14. Furniture size 21. Wall material 22. Ceiling material 31. Furniture pattern	10. Shape of ceiling 21. Wall material 22. Ceiling material 31. Furniture pattern	
		14. Furniture size	8. Shape of floor 9. Shape of walls 13. Shape of lighting fixtures 26. Ceiling color

Quadrant IV (Possible overkill)	4. Window views on nature 15. Window size 16. Ceiling height 19. Furniture arrangement 26. Ceiling color 28. Floor pattern 29. Wall pattern 30. Ceiling pattern	4. Window views on nature 15. Window size 28. Floor pattern 29. Wall pattern 30. Ceiling pattern 16. Ceiling height 17. Arrangement of lighting fixtures 18. Window arrangement 19. Furniture arrangement 25. Wall color 26. Ceiling color 27. Furniture color	2. Acoustical environment

7. Discussion and Implications

The goal of the study was to examine architects' and educators' perceptions of classroom design in traditional Korean schools in terms of promoting student development as well as focusing on the possibility of making suggestions for improvements in the design of classroom renovations. In Korea, school classrooms built using standardized drawings to cope with explosive population growth were prevalent until the 1990s. However, most schools still have this standardized classroom design because their construction costs are low, the design is good for efficient school management and teacher-centered instruction, and there is a lack of adaptable models for school renovation. With the educational paradigm-changing to student-centered and creative education, the renovation of traditional schools has been recognized as a priority task, making them into spaces that are both dynamic and affordable and that fit the new paradigm for present and future students. Thus, recent local government moves to renovate traditional schools overlap with the issues of increasing student engagement and teacher efficacy in student-centered learning contexts. For this, the study tries to examine the priorities in the renovation of traditional classrooms as student-centered and creative educational spaces. The major findings of the present study are as follows.

First, the ISA results reveal that classroom design was satisfactory and important in the "keep up the good work" quadrant, with the seven attributes (natural light, artificial light, shape of floor, arrangement of lighting fixtures, windows arrangement, floor color, and wall color). Thus, for an effective design, the classroom needs to maintain or enhance the quality of these important attributes. In the additional comparison between architects and educator groups, natural light was the only common attribute in Quadrant I (the "keep up the good work" quadrant; see Table 1). The classrooms had a wide distribution of sidelight windows for natural light from the standardized drawings, which was the maximum amount of window space that could be installed. However, a different understanding of the natural light in the classroom existed among groups. The best windows for natural light were in a south wall, with a view on the schoolyard and close to an external wall. Typical classroom windows found it difficult to receive natural light from multiple directions. Renovation cannot also change the external walls to expand the area or the location of windows for natural light on various floors of the school building (see Figure 1). The increasing use of multimedia and student-centered instructions in the classroom raises the needs to control natural light as part of the renovation process, such as by installing blinds, lubber, or light shelves to avoid glare from too much daylight (e.g., [57]). Thus, the requirements for sufficient amounts of natural light can be satisfied in the current situation, even though classrooms in daytime use artificial light because the amount of light is not properly distributed throughout the classroom. The architects seemed to understand the limitation and perceived the need for artificial light as belonging in the "concentrate here" quadrant.

Second, educators' experience in the classroom leads to different views of classroom renovation, focusing on Quadrant II. Items in this "concentrate here" quadrant indicate that attention should be directed and resources allocated to improve these attributes. Both school educators and architects recognize five attributes (natural ventilation, overall classroom shape, shape of the furniture, floor

material, and furniture material) as attributes that should be prioritized in classroom renovation. Interestingly, acoustical environment is an attribute in the "concentrate here" quadrant. However, additional analysis of group comparison shows different results regarding the acoustical environment of the classroom. Educators perceive classroom acoustics as of high importance but with low satisfaction, indicating that these acoustics have been performing poorly and whose improvement should be prioritized, whereas architects were satisfied with classroom acoustics, assigning this attribute to the "possible overkill" quadrant with lower importance. The responses of educators reflect their experiences as actual users in the classroom. Students in a classroom make noise in a variety of ways but, unfortunately, current classrooms as spaces for communication reflect sound in a diffuse manner, and their materials and structure lack sound absorption capabilities. Recently, the acoustic environment has come to be considered as important for proper implementation of the Korean national curriculum and educational policy that emphasizes student-centered learning and creative education, such as discussion, collaboration, and team-based learning activities [58]. Thus, classroom renovation should consider the issue of appropriate acoustics for the various types of noise that arise in the context of student-centered activities. Educators may understand the curriculum, daily situations, and the developmental characteristics of students in a classroom, whereas architects seem to lack this understanding of classroom acoustics since they tend to solve noise using noise-control products and materials.

The results of the study suggest the prioritizing of specific architectural attributes in designs for renovating classrooms in terms of promoting student development, based on the opinions of both educators and architects with their different experiences and areas of expertise. The results imply that coordination between relevant individuals and groups in designing and renovating classrooms is important for students' experiences. For this, it is necessary to build consensus among all stakeholders, including architects, teachers, school administrators, students, and parents, through meetings and workshops, to make a drawing or establish ideas as boundary objects, which help people in different communities cooperate on similar projects. Participatory design is a fundamental approach to involve all stakeholders actively. The diversity from the participatory design can direct the needs of the present students and teachers on their educational experience to pursue sustainable education opportunities. In addition, our study findings can impact on the renovation and construction of schools, particularly in developing countries that have standardized or little consideration of designing schools for student development and educational approaches.

This study has a limitation: biased responses may exist because of the use of convenience sampling because of the limited participants of the project. This study was conducted from the group of educators and architects in the renovation project of traditional school environments for students' accomplishment of their potentials for intellectual, psychological, and physical growth. Future studies need to conduct surveys with larger sample sizes or in other contexts (e.g., other local governments) to enhance the findings and make them generalizable.

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