Curriculum Design for Architectural Professional Education Using Pattern Languages

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This study presents the implementation of pattern language methodology in creating specialized curriculum for architectural professional education at Japan's technical colleges. Originating from architecture, the pattern language has been adapted to educational settings, providing a framework to articulate good design practices. At Nihon Kogakuin College and Nihon Kogakuin College of Hachioji in Japan, curriculum incorporating pattern languages for architecture learning and bioclimatic housing design has been developed and assessed for effectiveness through workshops and classes. The initiative aims to streamline learning objectives and evaluation curriculum, particularly benefiting novice students in their design exercises. The creation of this curriculum is grounded in a collaborative process involving faculty workshops and is poised to address the lack of unified standards in technical college education. Ultimately, this approach is expected to offer insights for future curriculum development, fostering creativity and practical skill acquisition in professional education.

Keywords: Technical College, Curriculum Design, Architectural Professional Education, Backward Design, Pattern Language

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1 INTRODUCTION

The purpose of this paper is to outline a new curriculum design methodology practiced in architectural education that applies Christopher Alexander's Pattern Language [1] methodology to curriculum design for professional education at Japan's technical colleges. Pattern language (PL) has been pointed out to support creative activities that could not be previously manualized, without falling into laissez-faire attitudes of simply "trial and error" by using "words of ku" [2]. Originally developed in the field of architecture [1], pattern language has been utilized in software development for computers and is currently employed in various fields such as management business, education, and welfare to articulate patterns common to good design and practice [3] [4] [5] [6] [7].

In Japan, professional education at technical colleges typically involves learning specialized knowledge through lectures and acquiring professional skills by progressively tackling performance tasks in each field. Performance tasks require not only written and practical tests but also the application and integration of knowledge and skills within real-world contexts.

At Nihon Kogakuin College and Nihon Kogakuin College of Hachioji in Tokyo, Japan, where the 1st author works, both the four-year architecture department and the two-year architecture department have introduced the concept of Pattern Language[1] proposed by architect and urban theorist Christopher Alexander into their professional education curriculum. The curriculum relies on the theory of backward design advocated by Wiggins and McTighe [8]. Backward design advocates that modules or subjects and the curriculum as a whole should be coordinated on the basis of essential questions, enduring understanding, and authentic assessment. According to Japanese pedagogical researcher Nishioka, backward design prescribes that assessment methods should be devised first, and that these assessment methods should include performance tasks [9]. Rather than merely involving written and practical tests, performance tasks are those

requiring knowledge and skills to be applied and coordinated to undertake some kind of practical task in a real-world context [9]. Architectural design exercises in architectural education are typical performance tasks. The core of the curriculum under development at Nihon Kogakuin College and Nihon Kogakuin College of Hachioji is the reform of the design exercises, which is the most important performance tasks in architectural education.

In the process of developing an architectural professional education curriculum based on the theory of backward design, we propose a methodology called "Pattern Language for Learning Content and Learning Methods in Professional Education Curriculum Design". This methodology uses a curriculum developed based on backward design theory and connects the design of performance tasks and the entire curriculum through pattern languages, in response to the following four issues. The first issue is the lack of a methodological model for developing performance tasks that become important in a professional education curriculum based on backward design theory, and for developing evaluation methods such as rubrics for these performance tasks. The second issue is the difficulty in constructing subject relevance in a curriculum based on backward design theory, where the challenge lies in realizing a curriculum in which performance tasks, practical subjects, and lecture subjects are related. The third issue is that modern society, as argued by backward design theory, is a changing society where the goals that should be envisioned first can also change, and simply stacking small goals of units or subjects does not necessarily achieve the larger goal (the vision of the talent to be nurtured). The fourth issue is the difficulty in incorporating a vibrant texture into a curriculum constructed by backward design theory, which could also be referred to as the "quality without a name" mentioned by Alexander [10]. We aim to solve these four issues through the methodology of pattern language by Alexander.

2 CURRICULUM DESIGN USING PATTERN LANGUAGES

We have compiled "Pattern Language for learning Architecture" (PLLA) , which is the pattern language of "how to learn" for students of architecture, and "Pattern Language for Performance Tasks", which is the pattern language of "what to learn" and provides good-practice tips for working on performance tasks. In regard to the latter, we have already created "Pattern Language for Housing Design by Bioclimatic Design" (PL_HDBCD) with plans to sequentially create pattern languages for different performance tasks. We are designing curriculum based on these (Figure 1) and assessing and verifying the effectiveness of this curriculum through research classes and workshops.

One of the "Pattern Language for Performance Tasks", known as PL_HDBCD, is designed to provide tips that stimulate the creativity of students in architectural design exercises. We have distributed PL_HDBCD during classes and divided students into experimental groups to participate in PL workshops and control groups in standard design classes. We evaluated the works using a rubric (Table 5 in the appendix) to identify the effectiveness of the pattern language [11]. PLLA is the pattern language that offers various tips for students studying architecture over two or four years. We conduct a one-day workshop using PLLA at the time of enrollment or when advancing to the 2nd, 3rd, or 4th year, annually. This practice has been shown to alleviate the anxiety of new students about "participation" in new learning experiences and the "acquisition" anxiety due to not seeing the whole picture of learning [12]. Additionally, PLLA has also proved useful in generating reflection and communication about "learning" and "career paths" for students who have advanced to their 2nd and 3rd years [13]. As conceptually illustrated in Figure 1, the authors are designing a professional education curriculum by creating pattern languages for each Performance Task and for the curriculum as a whole, in accordance with backward design.

The creation process of the pattern language, based on about 20 years of pattern language research by the Iba Laboratory at Keio University, consists of "Pattern Mining", "Pattern Writing", and "Pattern Symbolizing" is described in the Iba Style[14] [15]. In Japan, the Iba Laboratory has been experimentally creating pattern languages related to various human practices since the early 2000s, including learning methods, presentations, collaboration, living with dementia, disaster prevention, tips for planning, cooking, parenting, hospitality, early childhood education, and dialogue. These efforts have targeted a wide array of areas, and a significant number of patterns have been developed to date. Since 2017, municipalities, companies, non-profit organizations, public foundations, and individuals have begun creating their own pattern languages.

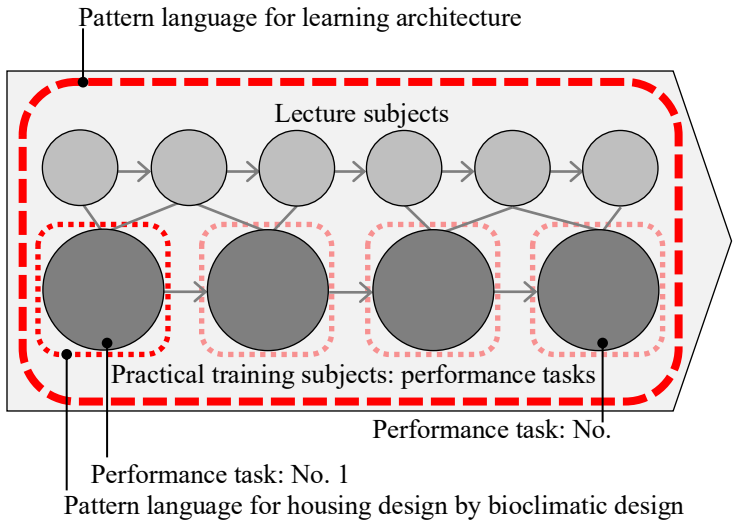


Figure 1: Architectural professional education curriculum concept diagram

Small circles represent cohesive lectures, while large circles indicate performance tasks. The small red dotted lines show the pattern languages for the learning content of each performance task. The pattern language for Performance Task has been completed for PL_HDBCD (Performance task: No. 1), and it is planned to sequentially be developed for Performance tasks No. 2 to No. n in the future (the right side represents the future). The large red dotted line represents the pattern language for learning architecture, which connects the whole curriculum. Utilizing PL allows for the integration of lectures and performance tasks, thus deepening the learning process. The gray lines connecting Lecture subjects and Practical training subjects (performance tasks) conceptually indicate that one performance task is associated with several lecture subjects.

3 PATTERN LANGUAGE FOR HOUSING DESIGN BY BIOCLIMATIC DESIGN

At the core of the curriculum currently being developed at Nihon Kogakuin College of Hachioji is to revolutionize design exercises, which are the most critical performance tasks in architectural education. The problems associated with conventional design exercises are organized as follows. First, the objectives of the design exercises are not clearly communicated to students in advance after having discussions among faculty members responsible for design exercises and other lecture subjects. Second, the "abilities to be acquired" and their evaluation methods for those tasks have not been sufficiently considered in advance. Third, due to the emphasis on student autonomy in design exercises beginners, especially, are often at a loss about what to do in design classes. Based on prior studies on the use of rubrics in drafting and BIM (Building Information Modeling, the construction ICT technology that creates 3D models of buildings in computers) education aimed at acquiring skills, the authors hypothesized that pattern language-based instruction would be effective in architectural design exercises, which require creativity from students in conceiving architectural design from scratch. We created teaching materials including "Pattern Language for Housing Design by Bioclimatic Design" and rubrics for design exercises and attempted instruction in design exercises using this pattern language [11]. To achieve a sustainable society, Bioclimatic Design is gaining attention in the field of architecture as a measure against the abrupt climate crisis caused by global warming. Bioclimatic Design is an architectural design that creates environments that evoke comfortable sensations in humans by taking advantage of regional climate characteristics.

A team of 10 full-time faculty members in the architecture department of Nihon Kogakuin College of Hachioji developed the "Pattern Language for Housing Design by Bioclimatic Design" (PL_HDBCD) (Table 1, 2) for the research class " Housing Design by Bioclimatic Design" held in December 2020, from June to November 2020, through approximately 20 faculty workshops lasting about 90 minutes each week. The workshops were led by the 1st author, and initially, faculty members who were not familiar with the methodology of pattern language gradually recognized the effectiveness of creating pattern languages for performance tasks as the number of workshops increased. Over six

months, through discussions in the faculty workshops, they reached a consensus on the "abilities to be acquired," the pattern language, and the rubrics, which became teaching materials with relevance to other subjects as well.

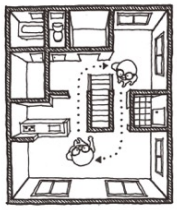
We attempted a new methodology by examining the content of performance tasks and creating pattern languages with multiple faculty members, while also developing the rubric for evaluation. This methodology goes a step beyond the traditional method of only creating rubrics, by generating pattern languages and rubrics that present the objectives, content, instructional tips, and evaluation methods for performance tasks, and using them for both instruction and evaluation. Furthermore, we clarified the effectiveness of instructional methods that utilize pattern languages in performance tasks. This allowed us to validate the hypothesis that instruction based on pattern languages is effective in architectural design exercises that require students to conceive architectural design proposals from scratch, demanding creativity.

Table 1: Overview of pattern names of PL_HDBCD

Category Name	Pattern Name
1 Macro-climate	1-1 Only One Earth
	1-2 Taking into Account the Macroclimate
	1-3 Nestle in with the Surroundings
2 Local Climate	2-1 Thinking from the Local Climate
	2-2 Memory of the Land
	2-3 Reading the Terrain
	2-4 Position of the Sun
	2-5 Catching a Seasonal Wind
	2-6 Life in Each Region
3 Micro-climate	3-1 Corresponding to the Neighborhood
	3-2 Creating a Microclimate
	3-3 Breathing Gardens
4 Indoor Micro-climate	4-1 To Each of Us, Our Own Place
	4-2 Circular Plan
	4-3 Large Living Room, Small Private Room
	4-4 Creating Indoor Microclimate with Stairwell
	4-5 Benefits of Semi-Outdoor Space
	4-6 Architectural Ingenuity

Category Name	Pattern Name
5 Light	5-1 Light Intensity
	5-2 Controlling of Light
	5-3 Effect of the Sunshade
6 Heat	6-1 Utilizing Solar Energy
	6-2 Thermal Visualization
	6-3 Balancing Temperature and Humidity
	6-4 Trapping and Blocking Heat
	6-5 Outer Wall as Skin
	6-6 Cool in Summer, Warm in Winter
7 Air	7-1 Harnessing the Energy of the Wind
	7-2 Wind in the Street
	7-3 Air Flow
	7-4 Water Vapor in the Air
	7-5 Circulating the Air
	7-6 Effects of Windows
8 Water	8-1 Enjoying Water
	8-2 Use of Rainwater
	8-3 Coolness Created by Water
9 People	9-1 Life’s Emotions

Table 2: Summary of PL_HDBCD (2-1, 4-2, 6-1)

No.	Pattern Name / Introduction	Context / Problem / Solution	Pattern Illustration
2-1	**Thinking from the Local Climate** When planning a house, we start by thinking about the area's characteristics from the perspective of the local climate.	We want to plan a house using bioclimatic design. If we start by thinking about the house's room layout instead of first identifying issues associated with the local characteristics and climate features of the project site and considering how to solve them, we will be unable to address the features of the local climate in the plan and we will not achieve a bioclimatic house. We consider a bioclimatic living space tailored to the local area by investigating the area's characteristics and climate features, identifying its issues, and running various simulations aimed at resolving those issues.	
4-2	**Circular Plan** We should consider a space where people, light, heat, and wind can move easily.	We are planning the floor plan of a house. If we do not plan for easy movement of people, light, heat, and wind through a house, indoor thermal and brightness environments will be uneven, and a comfortable house will not be realized. We capture the overall characteristics of light, heat, and wind in relation to the seasons in our region. We then design a house that allows light, heat, wind, and people to move appropriately within rooms.	
6-1	**Utilizing Solar Energy** Receiving and utilizing vast amounts of energy from the sun.	We are considering a house that utilizes solar energy. If we think only of using electricity, gas, oil, etc., which emit a lot of carbon dioxide, the cause of global warming, we cannot utilize renewable energy and cannot realize environmentally friendly housing. We know the types of solar energy and how to utilize it effectively, and plan a house that takes advantage of the benefits of solar energy in combination with the introduction of equipment and devices.	

4 PATTERN LANGUAGE FOR LEARNING ARCHITECTURE

We introduced orientation workshops using pattern language for incoming freshmen to study architecture at the technical colleges to alleviate their anxiety about "participation" and "learning" at the time of entrance and to help them learn essential and important aspects of architecture [12]. Furthermore, we conducted workshops using pattern language as introductory education for students who advanced to the second year to help them smoothly engage in the upcoming curriculum. The workshops also attempted to support reflection and communication on "learning" and "career paths" in specialized professional education through pattern language [13].

Approximately 10 full-time faculty members in the architecture department of Nihon Kogakuin College of Hachioji developed all 18 patterns of categories 1 and 2 of the "Pattern Language for Learning Architecture" (PLLA) through about 25 faculty workshops lasting about 90 minutes each week, from June 2020 to March 2021. Concurrently, we also carried out mining work for the creation of patterns for categories 3 to 9. From April 2022 to March 2023, three faculty members, including the 1st author, centered around weekly 1 or 2 workshops, created 63 patterns for categories 3 to 9, and completed the PLLA with a total of 81 patterns (Table 3, 4).

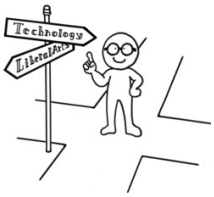
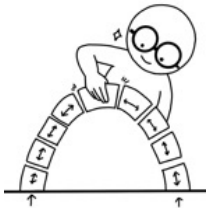
In our architectural professional education curriculum, we introduced the concept of pattern language and created "Pattern Language for Learning Architecture" to overcome the disadvantage of lacking subject relevance between lecture subjects and performance tasks in professional education, by linking the entire curriculum. We proposed a methodology for pattern language workshops as an introduction to professional education using our uniquely created pattern language, aimed at "participation" in new learning, and for acquiring the skills necessary to become a professional, as well as "learning" and "career paths" workshops using pattern language for becoming and pursuing a profession. We have demonstrated that workshops using pattern language can effectively reduce anxieties about "participation" in new learning and "acquisition" of knowledge for new students, and generate educational

communication about "learning" to acquire skills to become a professional and about "career paths" for pursuing a profession.

Table 3: Overview of pattern names of PLLA

Category Name	Pattern Name		
1 What is Architecture?	1-1 Standing at an Intersection	1-2 Dream and Work Hard	1-3 From Doorknobs to Cities
	1-4 Embodying History	1-5 Shelters and Monuments	1-6 The Importance of a License
	1-7 Built on the Earth	1-8 Architect Builder	1-9 Life of Buildings
2 Architectural Thinking	2-1 Think with Your Hands	2-2 Mind Walk-Through	2-3 On-Site Thinking
	2-4 The Body as a Measure	2-5 Wholeness and Details	2-6 Model Thinking
	2-7 Creating Questions	2-8 User-Oriented	2-9 Design for Co-Creation
3 Conception	3-1 First Feel, Then Think	3-2 Human, Things, Events	3-3 Catch the Context
	3-4 Grasp the Essence	3-5 Refine Again and Again	3-6 It will Come to You
	3-7 A Concept	3-8 Visualization of a Concept	3-9 Architecture with a Story
4 Preliminary Design	4-1 Dialogue with Others	4-2 Organizing Contexts	4-3 Fitting Context and Form
	4-4 Diagram Thinking	4-5 Cross-Sectional Thinking	4-6 Space, Time, Human
	4-7 Either Way, You Have to Complete It	4-8 Show & Tell	4-9 Building Beauty
5 Information & City	5-1 Natural Cities and Artificial Cities	5-2 Architecture as Symbol	5-3 Municipalism
	5-4 Architecture as Information	5-5 Digital Twin	5-6 Digital Fabrication
	5-7 Open City	5-8 Ethical Architecture	5-9 Cities as Communication
6 Working Design	6-1 Importance of Drawing	6-2 Full-Size Thinking	6-3 Determining Costs
	6-4 The Right Material in the Right Place	6-5 Structure and Forces	6-6 Facilities and Comfort
	6-7 Suitable Forms	6-8 Complete It	6-9 Well-Organized Architecture
7 Environment	7-1 Climate Crisis	7-2 Reading the Region	7-3 Microclimate Folds
	7-4 Creating Indoor Microclimate	7-5 Usher in the Light	7-6 Flirt with Heat
	7-7 Air Behavior	7-8 Utilizing Water	7-9 Quality without a Name
8 Building Construction	8-1 The Three Great Directors	8-2 All You Need is Safety	8-3 Setup and Cleanup
	8-4 Drawings for Making	8-5 Network Management	8-6 Cost Control
	8-7 Team Play	8-8 One More Thing	8-9 Make Seriously
9 Society	9-1 Death and Life of Architecture	9-2 Architect Thinking	9-3 Architectural Technician of the Town Healer
	9-4 Disaster Resilience	9-5 Architecture as an Asset	9-6 Renovation and Innovation
	9-7 Architecture as Common Space	9-8 Space Architecture	9-9 Tears of Architecture

Table 4: Summary of PLLA (1-1, 1-9, 6-5)

No.	Pattern Name / Introduction	Context / Problem / Solution	Pattern Illustration
1-1	**Standing at an Intersection** To be an architectural engineer is to stand at the intersection of technology and art.	We are about to study architecture. To study architecture, it is necessary to have the viewpoints of both technology and liberal arts, science and arts, hardware and software, etc. If you do not stand at the intersection of these two, in other words, if you do not have both viewpoints, you will lack the comprehensiveness necessary for "learning" architecture. We will pursue a high level of technical and hard aspects of architecture and a broad and deep interest in artistic and soft aspects of architecture, and try to learn both.	
1-9	**Life of Buildings** Buildings are imbued with life.	You feel buildings with your body. Certain buildings are imbued with a life that works on the emotions and minds that people feel with their bodies. If we do not believe that this life inhabiting is real, we will not be able to experience with our entire body the vibrant that is full of beauty and life. We focus our attention on the architectural space and try to intuit the life that resides in buildings. Try to concentrate on what you feel with your body as well as what you see with your eyes and think with your mind.	
6-5	**Structure and Forces** Imagine the structure and the flow of forces.	We are considering the structure of a building. If you do not understand the structure of an architecture and can not image the flow of forces that occur in it with sensitivity, you cannot design a good architecture. Structural design is handled by professionals in the field of structure, and as designers, we design buildings while imagining the flow of forces.	

5 CONCLUSION

The purpose of this paper is to outline a new curriculum design methodology in architectural education that utilizes pattern languages. We compiled "Pattern Language for Learning Architecture" and "Pattern Language for Housing Design by Bioclimatic Design" to summarize good practices for students at technical colleges learning architecture and tackling design exercises, performance tasks. We are designing a professional education curriculum for architectural education by creating pattern languages for each performance task and for the curriculum as a whole, in accordance with the principles of backward design. Pattern languages is utilized in curriculum design to tightly integrate the content of lectures with the particularly important performance tasks in the field of architecture. We are designing the curriculum and assessing and verifying its effectiveness through research classes and workshops. This research, as a study in Educational Design Research, will continue by creating, and then evaluating and verifying pattern languages for other performance tasks. Furthermore, this research has presented insights that can serve as guidelines for future curriculum development at technical colleges, where unified standards and models are lacking.

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APPENDIX

Table 5: Rubric for the design exercise "Housing Design by Bioclimatic Design"

Evaluation Perspectives \ Level		Level 5 Excellent, Comprehensiveness achieved	Level 4 Good, Unique perspective	Level 3 Fair, Basics achieved	Level 2 Not quite, Misunderstanding exists	Level 1 Efforts needed, Not understanding the assignment correctly
Bioclimatic Design Perspectives	Macro-climate	With a good understanding of the current state of the global environment and climate, gives consideration for the coexistence of the earth and human life [5 points]	In order to create a sustainable global environment, proposes concrete ideas to be incorporated into housing design [4 points]	Grasping the current state of the global environment and climate, understands the coexistence of the earth and human life [3 points]	Lacks understanding of how the current state of the global environment and climate relates to people's lives [2 points]	Lacks understanding of the current state of the global environment and climate [1 point]
	Local Climate	Incorporating local climate, including people's lifestyle and culture, into design, achieves comfort rooted in the local community [15 points]	Focusing on particularly distinctive parts of the local climate, designs concrete and comfortable spaces making use of them [12 points]	Studies local climate and understands its features [9 points]	Does not understand how to perceive local climate [6 points]	Makes no effort to understand local climate features [3 points]
	Micro-climate	Thoroughly studies the environmental characteristics around the site, and designs the exterior (garden) with consideration for the indoor environment [10 points]	Focusing on the surrounding environmental characteristics, incorporates them into concrete exterior design [8 points]	Researches the environmental characteristics of the area around the site and understands its features [6 points]	Does not understand the environmental characteristics of the area around the site [4 points]	Makes no effort to understand the environmental characteristics of the area around the site [2 points]
	Indoor Micro-climate	Designs indoor space with multiple diverse "places" that embody local climate features [10 points]	Comes up with "devices" to control the local climate, and realizes a comfortable indoor space [8 points]	Understands and organizes the impact of local climate features on the indoor environment [6 points]	Does not understand the impact of local climate features on the indoor environment [4 points]	Makes no effort to understand the impact of local climate features on the indoor environment [2 points]
	Light	Accurately understands the properties of light and designs a light environment that links exterior and interior spaces [10 points]	Proposes ways to control sunlight and creates designs for comfortable indoor spaces making use of them [8 points]	Understands the characteristics of natural and artificial light [6 points]	Does not understand the characteristics of natural and artificial light [4 points]	Makes no effort to understand the characteristics of natural and artificial light [2 points]
	Heat	By linking and combining various methods, achieves a comfortable thermal environment inside and also ensures openness to the outside [10 points]	Proposes ways to control the thermal environment and creates comfort by relating them to the composition of the interior space [8 points]	Understands and proposes the elements that create a comfortable thermal environment [6 points]	Does not understand the elements that create a comfortable thermal environment [4 points]	Makes no effort to understand the elements that create a comfortable thermal environment [2 points]
	Air	With a sufficient understanding of the air flow, achieves comfort integrating the airflow with the composition of the indoor space [10 points]	Proposes techniques utilizing air flow to regulate the indoor thermal environment [8 points]	Examines and understands the basic characteristics of air flow [6 points]	Does not understand the basic characteristics of air flow [4 points]	Makes no effort to understand the basic characteristics of air flow [2 points]
	Water	Creates proposals utilizing water both to create the thermal environment in the house and to "enjoy water" in daily life [5 points]	Devises ideas incorporating water into the living space, thereby helping to create a comfortable living space [4 points]	Researches and understands how to utilize water and make use of it in daily life [3 points]	Does not understand how to utilize water and make use of it in daily life [2 points]	Lacks an eye for utilizing water in daily life [1 point]
	People	One can readily imagine that the design evokes in people such emotions as surprise, joy, empathy, gratitude, and admiration [5 points]	The design contains unique ideas likely to evoke emotions in people [4 points]	Understands lively emotions and attempts to evoke emotions through design [3 points]	Does not understand lively emotions [2 points]	Makes no effort to understand lively emotions [1 point]
Perspective of Basic Requirements for Housing		The basic requirements of housing (function, performance, etc.) are met, and they have come together to create a house with livable, comfortable spaces [10 points]	The proposal has developed into a unique design with perspectives on the basic requirements of housing (function, performance, etc.) [8 points]	Understands what the basic requirements of housing (function, performance, etc.) mean [6 points]	Does not understand what the basic requirements of housing (function, performance, etc.) mean [4 points]	Makes no effort to understand what the basic requirements of housing (function, performance, etc.) mean [2 points]
Comprehensive Design Perspective		Having met all design requirements, the building has a well-balanced beauty incorporating area's characteristics [10 points]	Having established a unique basic concept, the proposed design is created with originality without compromising the overall balance [8 points]	Has a clear basic concept of design, and part of it has come to fruition in the proposed design [6 points]	A basic concept of design is presented but not reflected in the proposed design [4 points]	Basic concept is unclear and it is not possible to understand what the proposed design is aiming for. [2 points]

*Maximum score: 100 points