International Journal of Advanced Culture Technology Vol.8 No.1 199-206 (2020)
DOI https://doi.org/10.17703/IJACT.2020.8.1.199

IJACT 20-3-25

Design Learning Environment based on Affordance Concept for Convergent Design Education

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Abstract

I suggested the design learning environment based on affordance concept approach for supporting and improving learners' behavior and outcome for convergent design education in this study. The design learning space should be applied teaching and learning activity, especially learners' behavior, physical space condition to support the design thinking process. The design learning space needs openness, individuality and connectivity to support the learners' behavioral to immerse, participate, cooperate, understand, think and fulfill the design thinking process. The composition principles of the learning environment for convergent design education supports communication and collaboration among members for independence and interaction. The spaces for design research and teaching needs high privacy while facilitating visual communications through special materials and wall structure design. Also, for connectivity to improve the learners' physical and visual contact, the environment of the classrooms requires flexibility and mobility by providing an open space integrating unit cells for realizing learning purpose. These are provided by formed of an open structure for inducing visual communication and physical contact to involve the design activities and the mutual interchange.

Keywords: *Design Learning Environment, Design Thinking Process, Affordance Theory, Learners' Behavior*

1. INTRODUCTION

1.1 Research background and purpose

The design education is an activity process based on concreteness, which sets realistic and specific goals, content and methods, and experiences step by step approaches and activities for searching for problem solving methods. The purpose of this study is to suggest the direction of design learning environment applying the concept of affordance centering on convergent design education and design thinking process. It is a design factor that influences and supports the cognitive affordance and behavioral execution that induce user's behavior for classifying the learner's expected behavior of design process. Also the design education class model and suggesting the design learning environment for convergent design education. This study suggests the direction of convergent learning environment for design thinking process centering on learners' behavior from physical affordance and pedagogical perspective.

1.2 Scope of Study

The scope of this study is to define the concept of design thinking process and affordance, and to examine the relationship between design education and learning environment with a focus on learners' behavior. Based

Manuscript received: January 29, 2020 / revised: February 23, 2020 / Accepted: February 29, 2020
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on the step-by-step attitude of the design thinking education model, the physical characteristics of the design learning environment affecting the learners' behavior are examined and the direction of the design learning environment is suggested. The nature of design education is essentially active learning of problem-based learning (PBL). The PBL's emphasis is placed on hands-on or controlled experiences in the form of active learning, including linkages with various subjects and disciplines, action learning, and simulation. Therefore, it is necessary to set realistic goals, contents and methods and to present a series of processes and steps based on the design process reflecting specificity. In this study, we classify the convergent design education model and the stages of the design thinking process and apply the concept of affordance theory to suggest a guideline for design learning environment based on understanding of affordance to support and induce various behaviors for mutual design education process.

1.3 Research Method

The research method was carried out to examine the preceding research for the academic analysis of the theoretical background. First, the concept of behavior induction was grasped based on the concept of cognitive affordance and physical affordance in terms of environmental psychology through previous studies on the concept of affordance. Second, through the previous research and literature analysis, the theoretical background of the design education was examined, the characteristics of the convergent design education, the design principles of the learning environment, and the relationship with the learning environment were examined. Third, the concept and characteristics of the learning environment were analyzed from the pedagogical point of view, and the conditions of the learning environment and the learners' behaviors were classified based on the learning stage. Fourth, the design principles and directions of the design learning environment were suggested for the learners' behavior induction and support, focusing on design thinking process.

2. THEORETICAL BACKGROUND OF AFFORDANCE

2.1 Definition of Affordances

The first proposed affordance is a psychological term based on the relationship between humans, the physical environment and things. American ecological psychologist James J. Gibson discussed the concept of affordances in his book The Ecological Approach to Visual Perception. He defined the affordance that the user can anticipate possible behavior through the object [1]. His definition of affordance refers to the physical relationship between the user and the object as the physical property of the environment that enables behavior. Later, cognitive psychologist Donald Norman's concept of affordance, discussed in his book The Psychology of Everyday Thing was about human-computer interaction [2]. He defined the concept of affordance as a perceived characteristic of an object or a practical characteristic of an object and argued that it is a fundamental attribute that determines how to use it [3, 4]. In other words, the concept of affordance in the environment can be defined as a physical attribute that contributes to the formation of mutual relationships that predict and support user behavior.

2.2 Affordance Design and User Behavior

The definition of affordance by previous studies explains the interdependent relationship between environment and user perception. Norman sees it as dependent on the actor's experience, or on his relationship to knowledge, culture, and cognitive abilities. He defined affordance as an instrumental concept that focuses on the relationship between users, actions, and objects from a design point of view. In the physical space, the user perceived various affordances and collaborated to perform social interaction. The interaction between man and the environment is about perception of the environment, cognition, and human behavior and behavior. In this sense, his theory influences the induction of user behavior and behavior through environmental perception and cognition. Norman applied affordance theory to design to emphasize user-centered design concepts. He redefines the concept of affordance presented by James J. Gibson by studying the interaction between humans and the environment, with an emphasis on coordinating and designing environments that can be easily perceived effectively. Norman studied the process of storage and mapping of things, such as the nature of human perception and memory, the development of thinking and thinking ability, concepts, and

mapping. He defined physical behavior as real affordance and cognitive behavior as perceived affordance. Norman's behavior induction is a methodology from a psychological point of view to create a design environment from a user-centered point of view, and a physical affordance element to support, support, and promote physical behavior. The concept of behavior induction is designed to induce behavior through user's psychological stimulus when dealing with physical environment or product, or to allow the physical environment and product itself to react to the user. Table 1 explains that Norman insisted that affordance occurred when humans acted and defined the concept of affordance as a characteristic contributing to user's behavior decision and performance [5].

Table 1. Norman's affordance classification and concept

Classification	Concept	Element	Contents
Cognitive affordance	Design features that support, support and promote the object's perception and thinking process	Psychological model Conceptual model	Psychological Model: a new space for adaptation based on empirical space Conceptual Model: the structural correlation, movement, and operation of space provided by the designer
		Metaphor	Concepts of offering familiarity and comfort by suggesting understanding and using new concepts using familiar objects and concepts.
		Standardization	Concepts of offering familiarity and comfort by suggesting understanding and using new concepts using familiar objects and concepts
		Feedback	The concept of communicating information by providing the result and suitability of the user's actions
		Mapping	The concept that enables the prediction of the user's intentions and behavioral outcomes by means of the relationship between the control device for the design and the behavioral consequences resulting from it
		Visibility	Concepts that support users' perceptions and expectations by visually appealing important elements of space to provide a conceptual model for the efficient use of space
		Simplification	The concept of optimizing efficiency by modularizing or spatializing similar tasks around key essential functions
Physical affordance	Support and promote physical conduct	Behavioral induction	Concept of inducing action by making usage or function intuitively or empirically aware
		Behavioral constraints	It is divided into physical and socio-cultural constraints and prevents or minimizes the error of the user by proactive control of the behavior

2.3 Learning Participants and Behaviors

When designing the learning environment, it is necessary to apply the learner's motility and attitude change theory according to the facing direction. The conditions of various spaces and skills are determined by what attitudes the learning goals require of learners and have a direct impact on the formation of learner attitudes. Therefore, it is necessary to provide appropriate spaces, places, spatial attributes, and constructs for effective induction of learner attitudes according to the learning process. The composition of the size of the learners varies from individual to large groups depending on the learning style. Collective education requires flexible space design that reflects various learner sizes such as one-on-one teaching, mentoring and team activities. Behaviors that imply preparation for the participant, as required by the general learning and the context, are categorized into immersion, participation, cooperation, understanding of processes, thinking and execution in

Table 2. Consequently, learning environment requires environmental factors to induce behaviors and attitudes necessary for learning by stimulating the conceptual affordance of the physical space plan and the learner's conceptual model that satisfies the mental and conceptual models of cognitive affordance.

Table 2. Learners' behavior according to the learning process

Learners' behavior	Learning process
Immersion	Types of individual & small group
Understanding the process	Identify the context of the learning process Maintain the trajectory of the learning process
Participation	Group, team learning and participation in task activity Joint responsibility for learning outcomes
Cooperation	Competition and cooperation
Thinking & Performance	Feedback to complete learning activities

3. DESIGN EDUCATION AND LEARNING ENVIRONMENT

3.1 Design Thinking Method

The definition of scholars about design education emphasizes the educational potential of thinking power associated with the design process and the justification of design as general education. Charles L. Orwen, emphasizing the integrative value of design across all academic disciplines, argued that it should be general education, including professional education [6]. He also discussed the educational value of conceptualization, problem solution, communication, and visualization in design education. Nigel Cross who emphasized the general educational value of design that can be integrated with various disciplines, defined the essential value of design education as realistic problem-solving ability, structural thinking, and nonverbal thinking [7]. Design education provides the experiences about conceptual thinking and cognitive development through the development of practical learning activities according to themes and content. Developing conceptual thinking involves substantive planning, trials, discussions, and production processes according to learning content and purpose. The development of cognitive ability is experienced through the using tools and materials for visual expression and spatial understanding of objects. The design thinking method is the process of design by associating the design with the problem-solving process and effectively solving the multidimensionally changing problem. The general structure of the design process translates into problem understanding, problem solving, and evaluation [8, 9]. Figure 3 shows the preceding study of convergent design education, the design process forms a cyclical structure and is specifically applied to integrated thinking, creative ideas, and visual thinking processes in the problem understanding and solution stage. The process and stage characteristics of the design process and the learning process and types are classified around the cyclical stages of the design process is shown in Table 3.

Table 3. Design process and phase characteristics

Domain	Process	Stage
Understanding the problem	Identifying and understanding design issues Laying the groundwork for rational evaluation of design solutions	Set up ideas and directions for implementing the next steps
Problem solving	Design drafting process using designer's imagination Various creative techniques based on the analysis and arrangement in the problem understanding stage	Comprehensive Steps in Design Solutions
Evaluation of performance	Deriving and evaluating the best solution based on the resolution of the problems identified in the problem understanding stage.	Evaluation and reflection stage of solution

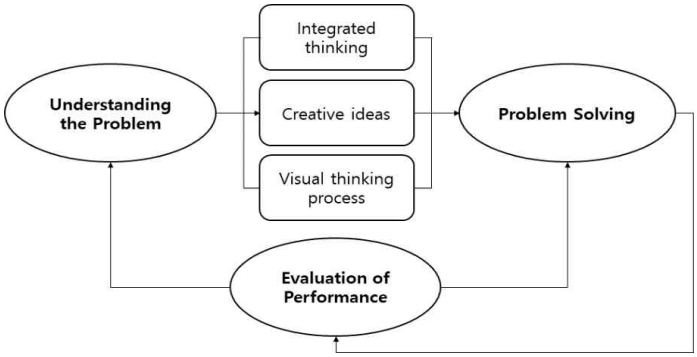

Figure 3. Circularity of the design process

3.3 Design Factors and Space Principles for Learning Environment

The ideal design method for the learning environment is a pedagogy approach to harmonizing learning objectives, concepts, and execution space. Pedagogy can be interpreted as a teaching method or a teaching method at the design level. Teaching methods are evolving in various ways, including lectures, group activities, task solving, and simulations, depending on the educational purpose and content. The design factors of the learning environment are classified into pedagogy, space, and technology in Table 4.

Table 4. Learning environment design factors and details

Factors	Design Details
pedagogy	learning objectives / participants / activities
space	spaces & places / properties / components
technology	media lab / smart classroom / experimental teaching method

Details of spatial design factors are categorized into spaces, places, properties, and components. From the pedagogical point of view, the types of learning methods include lecture-type delivery activities, discussion-type sharing and creation activities, integration activities for synthesis of opinions and alternatives, experimentation and realization activities to produce prototypes, and reflection of acquired knowledge. Reflection activity for children activates for motivation of learning in Table 5.

Table 5. Types of learning methods and learning activities

Types	Learning Method	Learning Activities
Communication	Lecture / Briefing	Knowledge and information transfer activities
Share and create	Brainstorming / Groups & Team Discussion	Sharing and creating various information and ideas
Integrated	Group and Team discussions / Votes	Combination of various information. Create alternatives by choice
Experiment and realization	Prototyping	Implemented as physical activities and objects that implement knowledge and planning
Reflection	Individual Reflection / Team Reflection	Ruminant Activity on Learning Outcomes
Activation	Icebreaking / Reactivation	Spiritual to energize learning. Physical activity

Table 6 shows the analysis of the opinions of the teacher and the expert in the design of future science classes for converged education (STEAM) and they defined the design principles in terms of flexibility, connectivity, intimacy, participatory cooperation and user centered [10]. Based on these design principles, development of logical thinking and discovery-based learning through planned laboratory activities, learning programs which are spatial models for supporting convergent learning activities through learning by doing and problem-based learning. The contents of the lessons, the flexibility of the learning space is required because it can be conducted in the form of collaborative projects related to the practice rather than unilateral knowledge transfer [11].

Table 6. Design principles and spatial features for converged education

Design principle		
Principle	Contents	Space feature
Flexibility	Implementation of various teaching and learning methods Use of teaching and learning resources	Variable space / open space / movable furniture
Connectivity	Connection with various learning resources Connection with nearby classrooms, local and onsite	Spatial Connection / Temporal Connection / Network System Connection
Intimacy	Psychological, cultural, physical and medical safety	User convenience / high accessibility
Participation & Cooperation	Promote and support learner participation and collaboration	Group Activities / Learning Process Sharing / Shared Space of Learning Outcomes

The flexibility of the space enables learners to collaborate among team members with diverse backgrounds and knowledge, and to create a space where students can improve their understanding of other studies and experience active, frequent contact and exchange. Individual spaces in each area can be secured in private, public, and mediated areas by opening and integrating learners' behavior centered on learning type, method, and unit for the staged approach of learning process and mutual communication between learners. The emphasis of the intermediary space such as securing the independence of space units for the convergent design education, provides open spaces to accommodate individual spaces, and in-between areas connecting individual spaces [12]. Jan Gehl defined accidental contact as passive contact, which means that one can see and hear other people's activities at low intensity and argued that the function of passive contact could lead to the next level of contact if people inadvertently participate in other people's activities, thereby increasing the level of communication between them [13]. The space design principle should be adapted the design process with learning process, type of learning and learning method based on the concept of openness and connectivity.

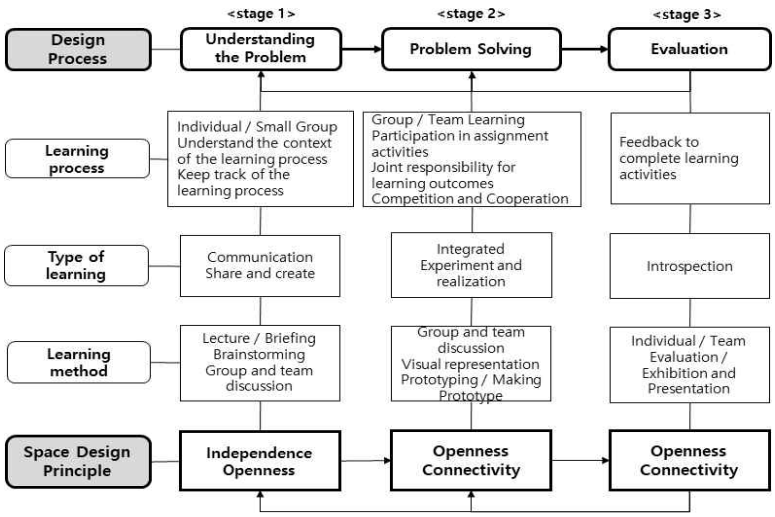

Figure 4. Circular design process and space design principle

5. CONCLUSION

The learning environment for inducing the learners' behavior in the convergent design education is effective in the open plan composition and the inter-planning space using individual and mediated space, open space and mediated space based on independence, openness and connectivity. These spaces are categorized into work unit spaces, communication spaces, and contact spaces, and are applied to the design The spatial principles

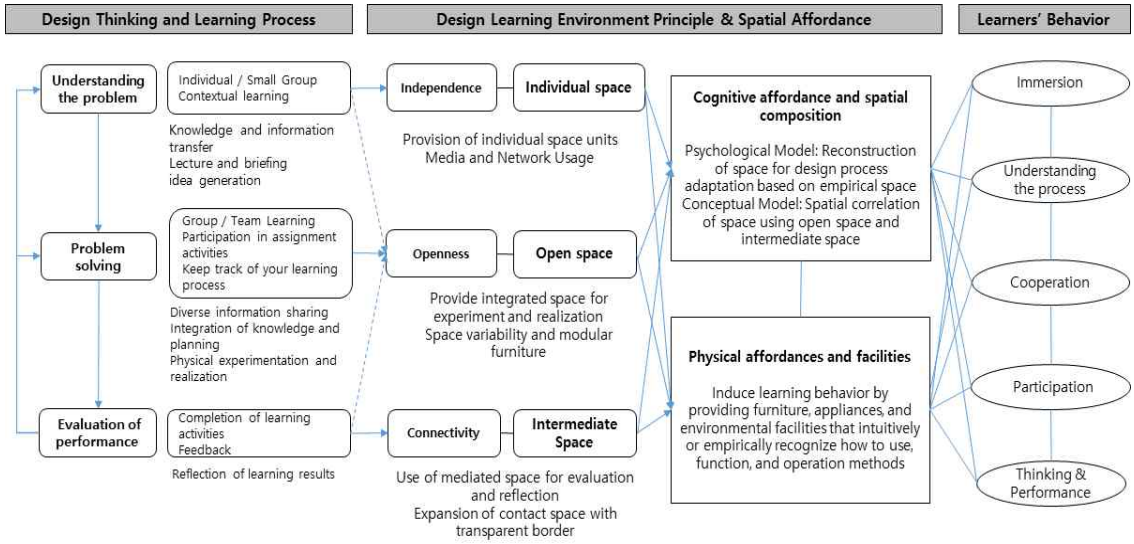

Figure 5. Design learning environment based on affordance inducing learners' behavior

and characteristics of design learning environment were represented as individual space, learning environment and contribute to learners' behavior for immersion, participation, cooperation, understanding of processes, thinking and execution. The learning environment for convergent design education is planned by securing individuality of space at the stage of individual immersion and understanding, and the openness and connectivity of space is required at the learning and evaluation stages of teamwork requiring communication and exchange. The space location and the size are adjusted to enable the arrangement of each space between the unit spaces. The independence of individual spaces by area based on design-oriented communication is required. The openness and connectivity of the space is secured in the team-based learning and evaluation stages where planning, communication and exchange are required. The space planning of the location and shape design affects the independence, openness and the frequency of contact among members and play a very important role in the learning process. The space would present the learners the cyclical structure and steps of the design process and implement spatial design to induce physical contact and visual communication to achieve learning goals through facilitating mutual exchange between members such as professors and learners. The connectivity is activated by arranging a studio, a multi-purpose hall, for the feedback process, evaluation, and reflection for the completion of learning activities.

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