FLATPACK CLASSROOM FURNITURE DESIGN 1:10 FOR SPATIAL LEARNING MEDIA FOR ELEMENTARY SCHOOL STUDENT

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Abstract

The design of classrooms in Indonesia currently adheres to government standards. However, varying conditions and situations across different regions result in classrooms with diverse shapes and layouts. This diversity can impact students' understanding and familiarity with their learning environments. This research aims to develop 1:10 scale flatpack classroom furniture designs made from child-friendly materials, featuring components that students can assemble themselves. This product enables students to learn about and recognize the layout of their daily classroom environment through play and simulation, alongside their teachers and peers. The approach involved school site observations and creatives experiments with various classroom furniture designs available in the classrooms. Respondents are 68 students from various State Elementary School in Indonesia, participated in the study. The findings can help school stakeholders provide a comprehensive and spatial learning experience for students.

Key words: flatpack furniture design, spatial learning, elementary school student

INTRODUCTION

Students' understanding of the classroom environment is still very limited, whereas it should play a role in enhancing their interest in learning. Therefore, the implementation of learning

activities at the elementary level requires a conducive atmosphere, both inside the classroom and in the surrounding school environment. A supportive atmosphere is essential for students to learn more effectively and comfortably (Fauziati, 2016). Students experience various spatial elements from the moment they enter through the school gate, pass by the field, walk through the classroom hallway, and enter the classroom, until they sit in their assigned seat. The various things they see within the school environment provide a wealth of information that can be absorbed through the senses, such as school buildings, plants, teachers and friends, as well as the furniture used. Formal education in Indonesia is mostly conducted in a structured manner, either inside or outside the classroom, within a school setting according to a predetermined schedule. The complexity of the learning material provided is adjusted to the student's educational level.

The classroom plays an important role in the learning process, allowing students to acquire knowledge, skills, and attitudes, which are the main goals of education in Indonesia. The function of the classroom is to serve as a place for theoretical learning activities, practical learning that does not require special equipment, or practical activities with specialized tools that are easy to provide (Lampiran Peraturan Menteri Pendidikan Nasional No. 24 Tahun 2007, 2007). The physical conditions standards in elementary classrooms are described as follows: the classroom serves as a space for learning activities, a practice that does not require special equipment or practice with available special tools. The number of classrooms must be equal to the number of study groups. The classroom has a maximum capacity of 28 students. The minimum classroom area-to-student ratio is 2 m2 per student. The minimum classroom area for study groups of less than 15 students is 30 m2. The classroom's minimum width is 5 m. Classrooms should have adequate lighting for reading and allow views of the outside. Classrooms should have adequate doors that can be properly locked when classrooms are not in use so that students and teachers can leave the room immediately in case of danger.

Each classroom is arranged according to these standards to support the students' learning activities so they can be carried out effectively. The proper selection and design of teaching tools and facilities will have a positive impact on improving the quality of student learning (Zainudin et al., 2018). Every classroom is organized according to these standards to facilitate effective student learning activities. The careful selection and design of teaching tools and facilities will positively influence and enhance the quality of students' learning experiences (Satriaji et al., 2020). Every classroom is organized according to these standards to facilitate effective student learning activities. The careful selection and design of teaching tools and facilities will positively influence and enhance the quality of students' learning experiences.

Figure 1. Classroom Configuration of Lebak Gede Elementary School, Sumedang, West Java, Indonesia
Source: Satriaji, 2023.

In the image above (Fig. 1), a configuration of a typical public elementary school classroom in Indonesia can be seen, using the classroom at Lebak Gede Elementary School, Sumedang, West Java, Indonesia as an example. The classroom has several common features, including: (1) A blackboard located at the front of the room as the main orientation for teaching. This front area is also where the teacher delivers instructional material; (2) The teacher's desk and chair are placed at the front of the classroom, usually on the left (or

sometimes the right), to facilitate supervision and classroom management; (3) The students' desks and chairs, made of wood, are positioned in the center of the classroom. Typically, the desks and chairs are arranged in neat rows and columns in a grid format. The design of elementary school chairs encourages children's learning activities in the classroom. (Purwaningrum et al., 2017) ; (4) Each classroom has windows on the left, right, or both sides. These windows also serve as a source of natural light for the classroom. Some classrooms cover the windows with paper to reduce distractions from outside activities; (5) Various other attributes supporting learning are typically placed around the classroom.

The walls often serve as the primary area for displaying classroom materials or learning aids. Posters of Indonesian heroes, multiplication tables, images of traditional houses, and class schedules are commonly found inside the classroom.The development of classroom interior design in Indonesia is shaped by two key factors. First, the modernist paradigm has heavily influenced the organization of classrooms. This approach emphasizes a systematic arrangement, with formal distances between objects, creating a structured relationship between teachers and students.

In this setup, both teacher and student bodies are disciplined to follow the prescribed layout, which is viewed as essential for fostering productivity and enabling scientific progress. Second, the influence of state ideology plays a significant role. The government sees education as a means to instill discipline and ensure obedience among citizens. As a result, schools function not only as places for academic learning but also as institutions that reinforce state power by imparting ideological values alongside scientific knowledge. (Saidi et al., 2023)

What if students were given the opportunity to explore the seating area they use in the classroom? What if they were allowed to simulate activities around their desks? These questions inspired the idea to create this 1:10 scale flat-pack classroom furniture design. Spatial issues can be addressed through various disciplines, one of which is interior design,

which focuses on the relationship between people and the spaces in which they carry out activities. (Demirbas, 2017)

Classrooms, or even the desks and chairs used by students, can have unique identities depending on how students and teachers utilize them. In the realm of interior design, the identity of a space is shaped by the integration of all elements within it, such as the ceiling, walls, floor, furniture, colors, lighting, and more, which are then interpreted in a specific way by the users of that space. This research focuses primarily on the furniture used by students in the classroom, specifically desks and chairs. These items are used daily by students for various activities, both structured and free. In the context of the classroom, design can play a role in facilitating learning activities. The learning stages of students, when related to the design thinking process, include observing, questioning, gathering information, processing information, and communicating ideas. These learning stages will be applied in the form of a simple model design module using cases and objects from the classroom that students encounter daily.

The standards set by the government regarding classrooms and their elements usually do not involve direct discussion with the primary users, namely students and teachers, despite being the main users of the classroom space and its furniture. Currently, there are not many products that assist students in understanding their territory within the classroom. The inability of desks and chairs to accommodate students' activities when using active learning methods has prompted efforts to innovate the design of student desks and chairs. (Zainudin et al., 2018)

As a result, students may feel less connected to the classroom and its furniture. The question that arises is how to enhance students' sense of belonging to the objects present in the school, thereby encouraging them to engage more actively in school activities. Based on this background, this research conducted several questions, namely:

1. How to help students to be familiar with their classroom?
2. What if studentswere given the opportunity to explore their personal area they use in the classroom?

3. What kind of items might student want to keep around their desk?
4. What kind of design can introduce spatial understanding to student in a fun way?

This innovative research aims to enhance students' sensitivity to the classroom through a product design in the form of a 1:10 scale flat-pack furniture model of student desks and chairs, which can serve as a learning aid. Models or prototypes are commonly used by artists, designers, and architects to convey ideas in three-dimensional form, making them easier for others to understand. Flat-pack furniture, also known as ready-to-assemble (RTA) or self-assembly furniture, refers to furniture that is sold in disassembled form and designed to be easily put together by the consumer.

The concept is popular because of its cost-effectiveness, convenience in transportation, and ease of storage. Instead of purchasing a fully assembled piece, customers receive furniture parts, often in a flat box, along with instructions and the necessary hardware. Several furniture components are packaged and provided with instructions on how to assemble them. (Agustiano et al., 2018)

The resulting flat-pack furniture design can create a new activity in the form of a game for arranging the configuration of desks and chairs in the classroom. By fostering design awareness from an early age, it is hoped that this will support and enrich the learning experience within the classroom. The flat-pack design of the desks and chairs takes into account the opportunities for student and teacher involvement in assembling, playing with, and implementing the furniture in real school settings.

RESEARCH METHODS

This research is conducted through a creative-based approach aligned with the fields of fine arts and design. The methods used include observation and creative experimentation, directly involving users to produce a suitable product. The resulting model will indirectly train students'

spatial abilities in arranging and assembling an object according to instructions, as well as their problem-solving skills. This innovative research is part of a social-based study aimed at addressing contextual issues within the community. (Wenzel & Babbie, 1994) The spatial elements highlighted in this innovative research are the desks and chairs used by students in the classroom. Several stages are undertaken to identify the forms and subsequently produce a product that is suitable for training and introducing students to the sensitivity and awareness of the furniture and classroom they use daily.

1. Data collecting and side visit

   The data collected includes the characteristics of children, the types of furniture used in schools, safe plastic materials for children, and various designs of classroom models. This data was gathered through direct surveys in the field as well as references from standard books, journals, and digital media.

   The chosen location is Lebak Gede Public Elementary School in Tanjungsari, Sumedang, West Java. This location was selected because it is a public school with appealing potential in terms of both location and resources. The students involved will be those in grades 4 to 6, considering their maturity in cognitive abilities.

2. Criteria and Concept

   The criteria for the model design are established by considering several aspects, particularly the characteristics and behaviors of children as users. Another important consideration is the clarity of information regarding the shapes of components and the assembly process for elementary school-aged children.

   The selection and use of materials that are safe and non-toxic are also prioritized, along with practical factors for packaging and mobility. Additionally, it is crucial that the resulting design incorporates elements of challenge and entertainment for children, given their high curiosity. More detailed criteria can be found in the table below. (Table 1).

Table 1 – Design Criteria and Consideration

Criteria	Description	Information
Dimension	The product is designed to be easily portable and packaged. It has dimensions that are neither too large nor too small, making it practical for use	The dimensions of the flat-pack furniture design are kept compact so that it can be assembled on each student's desk. 10,5 x 14,8 x 0,3 cm (A6) Postcard size
Shape and form	The components of the student desks and chairs are arranged in sheets.	The components of the desks and chairs can be assembled from 2D into a 3D shape of furniture at scale 1:10
System	Using a RTA or flat-pack system, the components can be assembled into the form of student desks and chairs	The product can be assembled by students into the desks and chairs they commonly use in the classroom
Material	The materials are child-friendly, as they will be used by elementary school students.	The prototype is created using 3D printing methods with PLA+ filament, which is child-friendly because it is non-toxic and safe for food contact
Color	Bright colors are used, aligning with the characteristics of children	The colors currently used are limited to those available based on the filament.

The concept behind this design is to create a product that can be self-assembled (DIY) by students and teachers, while also inspiring students to be creative. The assembly process will enhance students' motor skills as they practice hard skills such as cutting, gluing, attaching, and composing objects.

3. Ideation
   The main forms to be constructed are desks and chairs for elementary schools. Various models and shapes of desks and chairs used at the elementary level have been collected. The most suitable and representative designs are selected to be sketched in a manual version, illustrating the components that make up the product. The results of this ideation process will serve as the foundation for the modeling process.

4. Modelling
   The modeling process uses SketchUp software to translate the components of the selected table and chair model. The modeling process uses a 1:10 scale which means that the

product will be 10 times smaller than the actual object.

5. Prototyping
   The prototype is created using a 3D printer, specifically the Creality K1, which won the Red Dot Award 2024 in the field of industrial design. The expected results must be highly precise according to the design, as the assembly system is taken into account. The filament material used is polylactic acid (PLA), which is known for its strength, durability, and eco-friendliness.

6. Assembly Test
   Assembly testing is conducted to determine the precision level of the flat-pack furniture design module concerning the joints of each component. At this stage, we can also assess how long the assembly takes.

RESULT

The forms of desks and chairs used in elementary schools today are quite diverse, including single student desk and chair sets, models designed for two students, and more modern designs (Fig. 2). The primary materials for these desks and chairs are mostly made of wood and aluminum. The wood commonly used is Meranti, which appears sturdier but is heavier compared to fabricated aluminum desks and chairs, which are lighter but may seem more fragile when handled.

Figure 2. Several models of student desks and chairs used in elementary schools include the single-seater model (left), the long bench model (middle), and the aluminum model (right)
Source: Satriaji, 2024.

The desks and chairs used and translated into a 1:10 scale model in this research are those made of wood. The reason for selecting this model is not only because it has a simpler design, but also because it is the most commonly used type in public elementary schools throughout Indonesia (Fig. 3).

Figure 3. Desks and chairs for students are made from meranti wood.
Source: https://e-katalog.lkpp.go.id/

The chosen design is a set of desks and chairs for the classroom with a capacity for one student, ensuring that each student has their own desk and chair. The features of these desks and chairs are simple yet functional. The student chair has a rigid and upright design, with a backrest that supports the student during the learning process. The backrest is also often used by students to hang their bags. Each chair's four legs are equipped with stabilizing structures to maintain its shape even when weight is applied. The underside of the desk includes a drawer for storing bags and stationery. The standard dimensions of the desks and chairs can be found in the table below. (Table 2)

The selected desks and chairs are then broken down into separate components. The classroom chair model is divided into five components: the backrest and rear legs, front legs, seat, right leg connector structure, and left leg connector structure. The seat and backrest sections feature a grid of holes measuring 3.5 x 3.5 mm. These square holes serve to integrate other objects into the product or for assembling the flat-pack furniture design of the desks and chairs onto a specific base. The seat has 16 holes, while the backrest has only 4 holes.

Table 2 – Student Chair and Desk Dimension (Diknas, 2009)

Furniture	Dimension (cm)		
	Length	Width	Height
Single Desk	60	55	65-71
Double Desk	120	55	67-71
Chair	38	38	40-44
Bench	120	38	40-44

The desk model consists of six components: the front legs, rear legs, left side cover, right side cover, tabletop, and drawer cover. The tabletop features holes to facilitate the storage of items on the model. Each component is configured into a frame sized like a postcard. The configuration of all the desk and chair components requires three sheets of this frame (Fig. 4). The postcard size is chosen for easy transport and could also serve as a souvenir product for the school. However, as of this writing, considerations regarding effective packaging have not yet been fully developed.

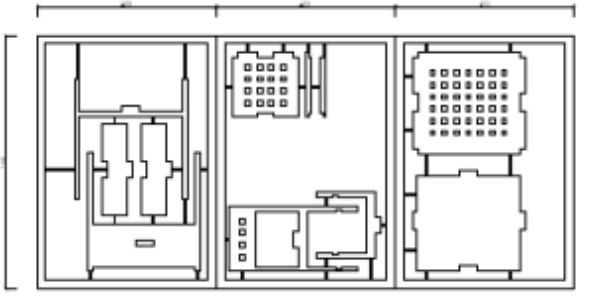

Figure 4. Table and chair component
Source: https://e-katalog.lkpp.go.id/

Based on the configuration above, it can be observed that there are still many empty spaces between the components. This condition presents opportunities to add other objects in the surrounding areas. Before incorporating items into the gaps between the products, students are asked what they feel is still

lacking. Students are given the following question: "Please write down 3-5 objects you would like to have in the classroom" (Fig. 5).

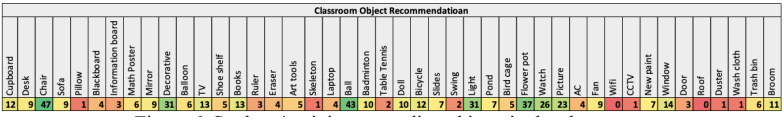

Figure 5. Students' opinions regarding objects in the classroom.

There were 63 elementary school students who responded to this question. From the responses, several objects that students desired to have in the classroom were identified, including chairs (47 votes), balls (43 votes), lamps (31 votes), and flower pots. These results will be used as a basis for selecting objects chosen by students as supportive equipment within the classroom. For the final design, we included some student's choices, as examples, ball, table lamp, umbrella, aquarium, tumbler, mug, shoes, etc (Fig. 6).

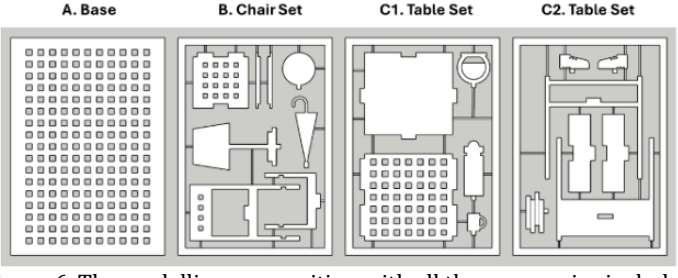

Figure 6. The modelling composition with all the accessories included.

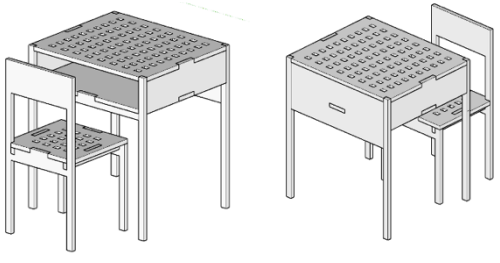
Figure 7. Modeling is created using software by combining the components.

The components are then assembled and simulated into the three-dimensional forms of desks and chairs (Fig. 8). The initial expectation was that the assembly process would not require glue; however, it turned out that the sizes were too large, making it difficult to assemble the components properly.

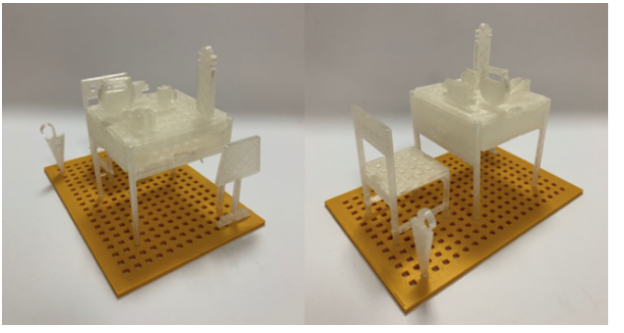

Figure 8. The assembled product model.

To make it more colorful, several colors can be combined together according to the student's preferences. As examples, clear color filament can be combined with yellow, red, green or blue to make it more personal.

DISCUSSION

Based on the research findings and the products developed, several points can be concluded as follows:

a. The classrooms of public elementary schools in Indonesia have established standards set by the government; however, their implementation varies greatly. These standards seem inadequate to accommodate the characteristics of students, who have a high level of curiosity. Students appear to be compelled to use the classroom and their seating area as they are, without opportunities for personalizing their territory.
b. The flat-pack design of the desks and chairs at a 1:10 scale is primarily intended to enhance students' understanding of space, including their territory within the classroom, particularly the area around their seats. This design also provides opportunities for students to be creative with

various accessories provided, which they can then compare and discuss with friends, teachers, or parents.

c. The flat-pack classroom furniture design still has potential for further development according to the needs of each school, addressing contextual issues to make it more accessible and understandable for children.

CONCLUSION

This flat-pack furniture design represents an effort to create a product that can be utilized by both students and teachers in the classroom. For students, this design provides information and experiences about the area they occupy during their school years. Additionally, it helps cultivate students' sensitivity to shapes by observing the existing components.

Creativity, courage, and freedom of expression are also nurtured through the assembly process. For teachers, this design can serve as an introductory activity at the beginning of the school year, where each student is asked to assemble their furniture and then showcase it to their classmates. The hope is that this will enhance students' understanding of space.

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