



Participatory Design to Develop Montessori Modular Furniture for Pre-Prosperous Community Learning Center

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Abstract. Education plays an important role in human development. Through learning, humans are enabled to write, speak, and create. The Covid-19 pandemic has disrupted education, especially for those who depend on free educational programs that rely on volunteers for day-to-day operation. Children in the golden age are the most affected. Online learning can never cover the social interaction provided by offline learning. This research was done in Rumah Langit, which is a free community learning center for children, located in Rusunawa Urip Sumoharjo, Surabaya. After several months of getting to know the people involved, their surrounding environment, and participating in their daily activities, it could be clearly seen that Rumah Langit was lacking learning media. Especially learning media for children in the golden age who are often very curious and are in the stage of developing their five senses. OTTM (One, Two, Three, More?) is a modular furniture unit specifically developed for learning media at home for preschoolers, designed using the six steps of the design thinking method (Understand, Observe, Define Point of View, Ideate, Prototype, and Test). With its endless configurations, OTTM can be used as an open storage, a table and chair set for preschoolers, a seating chair for adults, and learning media for kids. It was inspired by the Montessori method of learning, which allows children to be creative and learn at their own pace. OTTM offers an easy and fun way of learning at home for children, especially for children in the golden age. By using OTTM, children can learn about basic counting, colors and how primary colors create secondary colors, and about shapes, from geometric to organic shapes.

Keywords: *children; education; modular furniture; Montessori; Rumah Langit.*

1 Introduction

Rumah Langit is a free community learning center for children located in Rusunawa Urip Sumoharjo. This facility guides 35 children ranging in age from 4 to 15 years old. Apart from teaching basic education such as mathematics, English, and Bahasa Indonesia, they are also aware about the importance of the

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children exploring their creativity. Sadly, since the occurrence of the Covid-19 pandemic, the number of volunteers has continued to decline, now leaving only 2 volunteers to teach 35 children. Through observations and many casual interviews, the authors began to understand the actual struggle of having to teach 35 young individuals who have different needs and wants. Apart from the reduced number of volunteers, Rumah Langit is also struggling economically to meet the learning and creative needs of their pupils. Even simple things like coloring pencils or coloring books are rare at Rumah Langit. After learning about these problems, the author got the idea to create modular furniture using participatory design that not only meets the needs of the space and the users but also meets the educational and economic needs of Rumah Langit.

2 Methodology

This study started in early February 2021 and ended in June 2021, the author used the design thinking method, which is divided into 9 stages shown in Figure 1. Design thinking is an innovative problem-solving process, rooted in a set of skills [1].

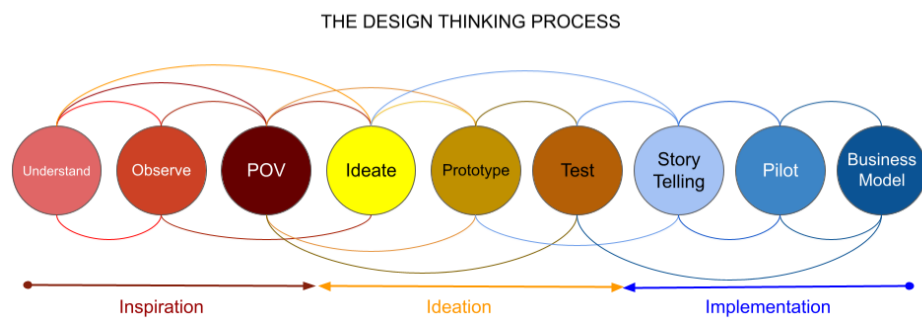


Figure 1 The design thinking process (adapted from Gibbons, 2021 [2]).

2.1 Understanding

At this stage, literature data collection, typology, and gaps of knowledge were determined to act as a guide for this research.

2.1.1 Children

According to the Indonesian dictionary, etymologically, the definition of a child is a human who is still small or an immature human being, and according to the Indonesian Ministry of Health, in 2009, the categorization of children's ages is divided into three periods, namely, 0-5 years old, called the toddler period; 6-11 years old, called childhood; and 12-16 years old, called early adolescence [3].

2.1.2 Participatory Design

Participatory design is a form of research that was first invented in Scandinavia in the 1970s and 1980s.

“Unlike conventional research, which is directed primarily at producing results of interest to those beyond the immediate research site, an essential goal of action research is to achieve practical or political improvements in the participant’s lives (e.g., less routine work, greater autonomy, more effective tools). The researcher becomes directly involved in the ongoing work and feeds results back to the participants” [4].

2.1.3 Montessori

“The Montessori method is essentially the provision of education based on an extraordinary respect for children’s ability to learn about the universe without interference” [5].

2.1.4 Modular Furniture

Furniture in general means a place to store something in a fixed position or has a certain place in a room and is made from certain materials and stands alone.

“A modular product design is a design plan consisting of several separate modules that can be easily disassembled, installed, and re-configured. Having a generally simple form, modular furniture can easily adapt to the needs of the user.” [6].

2.2 Observe

In this stage, field observations and casual interviews with Rumah Langit volunteers were conducted on a regular basis for the first two months. From this step, the author not only could picture Rumah Langit’s goals and needs but also feel the location’s atmosphere by participating in the daily activities. Rumah Langit is located on the third floor of Rusunawa Urip Sumoharjo. This 24- m^2 room contains ten folding tables, one table to put a TV set on, and two closed storage units to store books and the children’s creative equipment. The existing layout and photos of existing location are shown in Figure 2 and 3.

After some observations and casual interviews, some of the main problems could be concluded. The first problem concerned the two closed storage units, which were not sufficient to store all the books and the children’s creative tools. The room also lacked decoration and color. Considering that children are visual

beings, it is very important to play with shapes and colors to help stimulate their brains into thinking in a more creative way [7]. The last problem was the lack of an ergonomic chair for the teachers of Rumah Langit, especially those of older age.

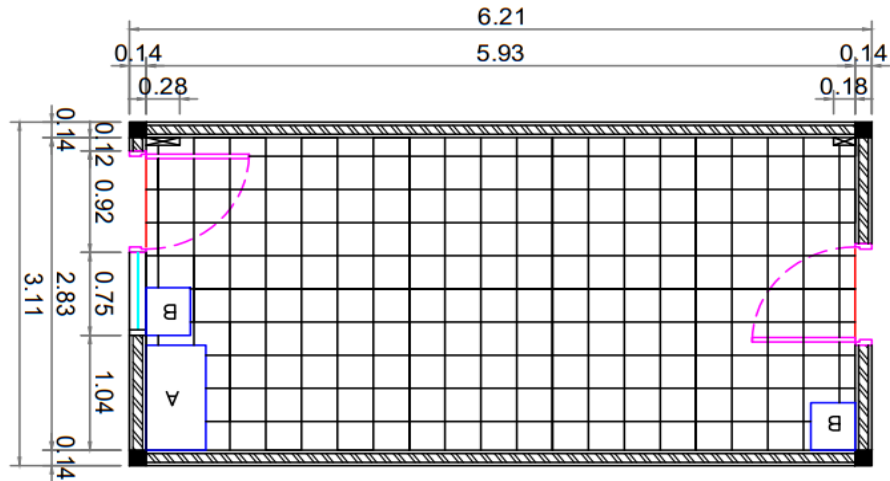
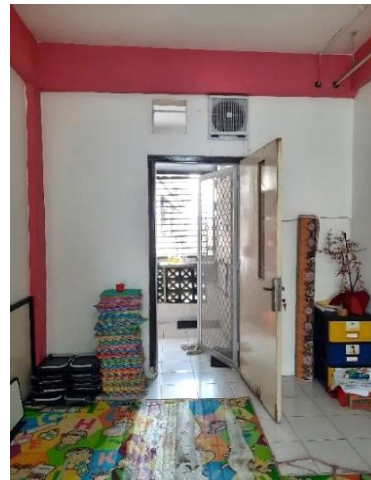


Figure 2 Rumah Langit layout, with all dimensions in meters
(Source: Pranoto, 2021).



(a)



(b)

Figure 3 Rumah Langit: (a) view of the front of the room; (b) view of the back of the room (Source: Pranoto, 2021).

2.3 Point of View

Based on the data and the information that had been collected, an affinity diagram was made to find out what needs and problems existed in Rumah Langit. Placing oneself in the position of Rumah Langit was easy for the author after several meetings and participating in activities at the location.

2.4 Ideate

At the beginning of this design process, a focus group discussion (FGD), which included the authors and the tutors of Rumah Langit, was held in Rumah Langit's study room as shown in Figure 4. Here, the two tutors talked about their hopes from this research. Considering how narrow the space is and the number of its daily users, the number of scattered items makes the space seem smaller than it actually is, so the presence of a storage unit would be very helpful.



Figure 4 FGD documentation at Rumah Langit (Source: Pranoto, 2021).

After that, we thought about what form of storage would be suitable for Rumah Langit. Here, one of the tutors stated her desire to have open storage that would give the impression of a mini-library in the room. In addition, during this FGD, one of the tutors advised that we should not use MDF as furniture material, considering that the room has a lot of insects, so the MDF would not have a long lifespan. After that, the two tutors talked about the difficulty of playing media in the room, especially for children in the golden age who should be trained often, both in the sensory and visual fields. With that in mind, the authors came up with the idea of integrating the aspects of open-ended toys in the furniture in such a way that they could be easily removed and stored after use. At the end of our discussion of furniture design ideas, we realized another problem, which is the

absence of chairs with an ergonomic height for the tutors, especially for one of the tutors 60 years old. Activities that require her to sit on the floor for a long time threaten the health of her joints, so the idea to create a modular furniture unit for open storage, playing media, and sitting emerged.

With the information that had been collected through the FGD, a concept for the design that could solve the problems that existed in the location was chosen, namely the Montessori concept. Montessori is a learning method for children based on the belief that children are able to develop their intelligence without help from adults. Using the Montessori concept, a modular furniture design was developed. This modular furniture is intended not only to meet the needs of the space and the users but is also expected to meet the educational needs of the pupils, especially children in the golden age. Some educational elements such as primary and secondary colors, organic and geometric shapes, and basic numbering were applied in the design.

2.5 Prototype

With the Montessori concept in mind, the design of OTTM modular furniture was made in the SketchUp 3D software. This furniture was specifically designed in modular form to suit the conditions of Rumah Langit's study room, which is quite narrow. By using a modular approach, the furniture can be changed easily to suit the needs of the children and the tutors. Throughout the whole design process, the author received a lot of input from Rumah Langit, starting from the selection of furniture materials, colors, to adding learning aspects such as English language and numbers to the furniture.

2.6 Test

After exploring many alternatives and revisions, the final design was sent to a handyman. The material was cut using CNC cutting, followed by a furniture construction test, and ending with the finishing process using a water-based finish.

2.7 Storytelling

A storytelling canvas was made to explain the purpose and the ultimate expectations of the design.

2.8 Pilot

The ready-to-use modular furniture was tested at Rumah Langit along with a macrame training. At this stage, we could see the success rate of the design, whether it served its intended purpose or not.

2.9 Business Model

Lastly, a business model canvas of future plans for Rumah Langit was created. This canvas was made as a guide for Rumah Langit if it wants to develop the macrame skills that are taught to the children into a business idea in the future.

3 Results

The prototype from the participatory design method implemented resulted in a modular furniture design dedicated to supporting the educational activities of Rumah Langit. OTTM modular furniture was designed to cater various activities that may be organically developed by the children during their session in Rumah Langit (see Figure 5).

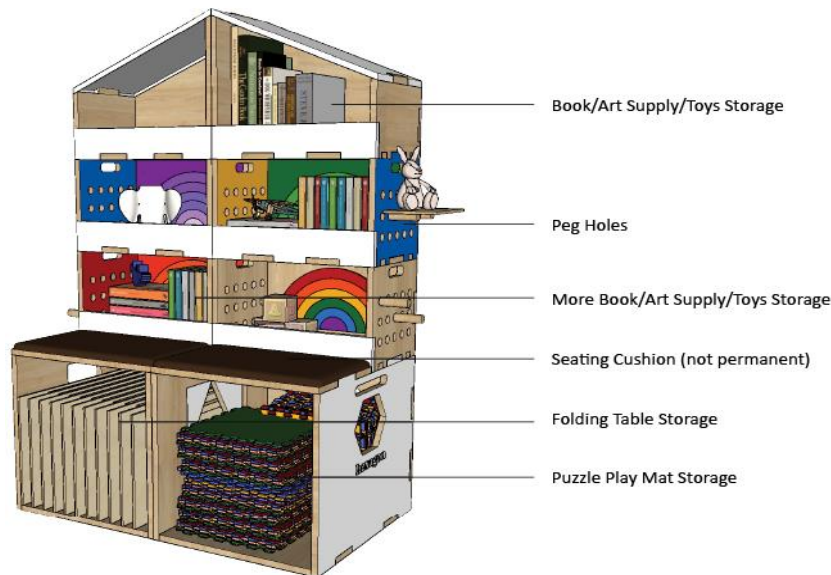


Figure 5 OTTM (One, Two, Three, More?)
(Source: Pranoto, 2021).

The use of colors teaches children to recognize how when primary colors are mixed with each other, a secondary color is produced. In addition, the coloring in the rainbow area can be used to teach the children about color gradations. The rainbow arches can be disassembled and used as a medium for playing and children's media to be creative with organic arrangements, like in Figure 6 below.

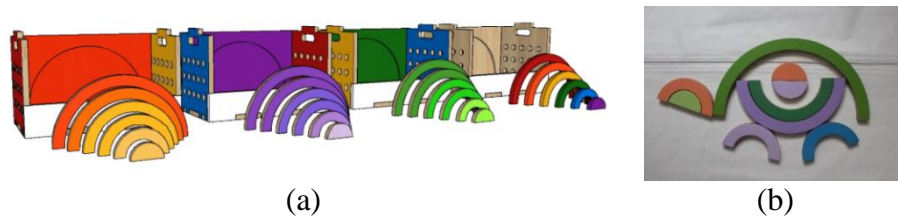


Figure 6 (a) Colors functions of OTTM, and (b) example of rainbow stack use (Source: Pranoto, 2021).

The merging of Part A and Part B into one like the picture below produces a new learning media to introduce children to geometric shapes (see Figure 7a). There are 6 pieces with different shapes on each side that are equipped with the name of the shapes in English. OTTM can also be used as a medium for learning numbers and their sequence for early childhood. OTTM is equipped with 30 wooden dowels with a diameter of 25 mm and a length of 5 cm, numbered from 1 to 30 as shown in Figure 7b, with which the children can be taught to sort the numbers by using the side of parts C, D, E, or F.



Figure 7 (a) Shape functions of OTTM; (b) numbering function of OTTM (Source: Pranoto, 2021).

This modular furniture is called OTTM, which stands for *One, Two, Three, More?* As the name implies, this furniture can be changed into many different configurations according to the needs of the space and its users. OTTM has a length of 100 cm, a width of 60 cm, and a height of 150 cm (dimension details presented in Figure 8).

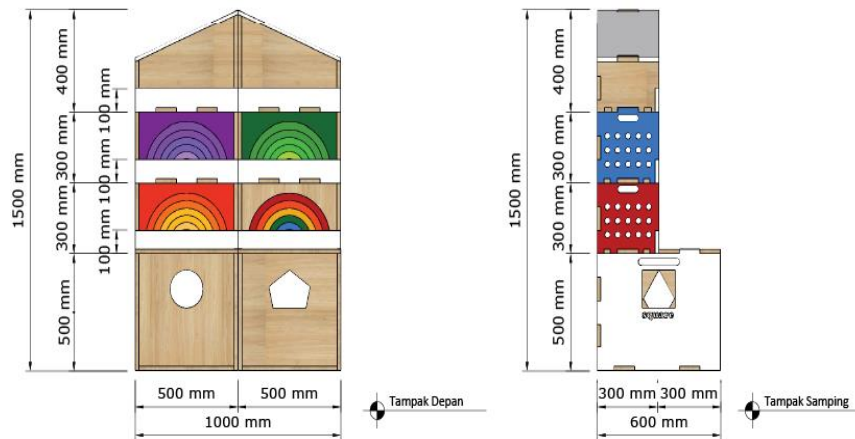


Figure 8 OTTM both in front and side view (Source: Pranoto, 2021).

Figure 9 shows how OTTM is divided into eight main parts, namely, parts a, b, c, d, e, f, g, and h, which are removable so they can be easily configured into new shapes.

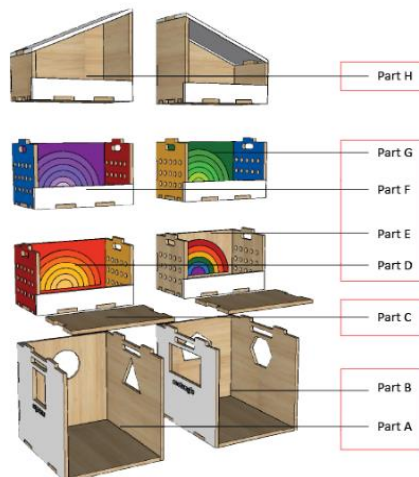


Figure 9 Division of the parts of OTTM (Source: Pranoto, 2021).

OTTM has 8 standard configurations with different functions as shown in Figure 10-13. The first one is called The Ginger Bread House and is inspired by the name Rumah Langit. This configuration can be used as open storage and seats for two persons in the front, measuring 30 x 50 cm per seat (with removable cushions). The second one is called The Red Queen. It has the same function as

configuration 1, but in this configuration, the seating is only for one person, with a size of 50 x 60 cm, in the middle.



Figure 10 (a) OTTM first configuration, and (b) OTTM second configuration (Source: Pranoto, 2021).

The third configuration is called Jack and the Giant and it shows the flexibility of OTTM, which can be separated into 2 separate pieces of furniture, i.e. one open storage unit and one seat measuring 50 x 60 cm. The fourth configuration is called The Three Little Pigs. It is a development of configuration 3, where it can be seen how OTTM can be separated into 3 separate pieces of furniture, one open storage unit and 2 seats sized 50 x 60 cm per seat.

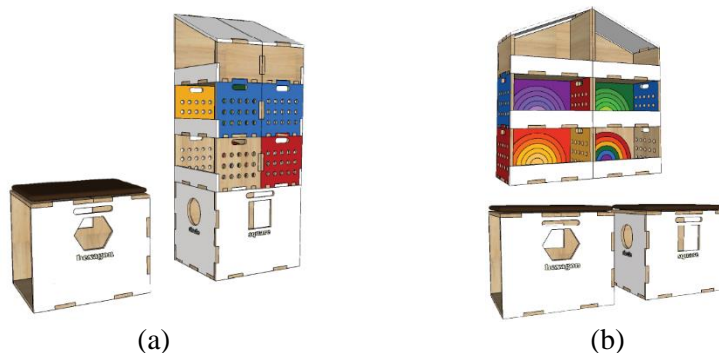


Figure 11 (a) OTTM third configuration, and (b) OTTM fourth configuration (Source: Pranoto, 2021).

The fifth configuration is called The Grim Brother, and in this configuration OTTM functions as a set of two children's chairs and tables, where the seat and table measurements are adjusted to the ergonomics of children aged 4 to 8 years. The sixth configuration is called The Tea Party and is a development of

configuration 5, where the function of OTTM is as a set of one table and two chairs for children, and an open storage unit.

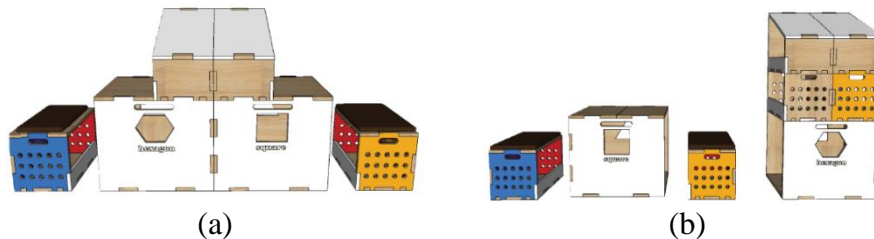


Figure 12 (a) OTTM fifth configuration, and (b) OTTM sixth configuration (Source: Pranoto, 2021).

The seventh configuration is called The Cheshire Cat and is where OTTM can be used for creativity development of Rumah Langit's children. In this configuration, OTTM can be used as a supporting pillar for making macrame. By utilizing peg holes and a 150-cm long hanging pole that supports the macrame-making process. Lastly, the eighth configuration of OTTM is called The Far Far Away Castle. Similar to configuration 7, this configuration serves as a tool for making macrame but the difference is that configuration 7 is intended for making macrame in a sitting position, while in this configuration macrame making is done in a standing position.



Figure 13 (a) OTTM seventh configuration, and (b) OTTM eighth configuration (Source: Pranoto, 2021).

The design realization process began with a consultation with a carpenter, where at this stage the furniture got a construction change. Where previously there were no joints, now dove-tail joints were added. These joints act as construction reinforcement along with the help of screws. The furniture was made from 18-

mm plywood using a CNC cutting tool to get precision cutting (see Figure 14a). After that, the furniture entered the finishing stage, in which water-based biovarnish paint was used that is safe for children (see Figure 14b).

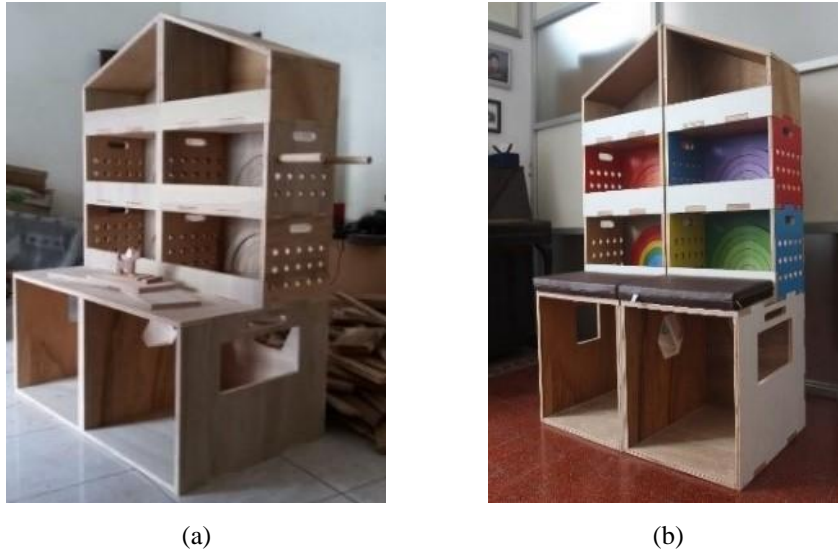


Figure 14 (a) OTTM after CNC cutting process, and (b) OTTM after finishing (Source: Pranoto, 2021).



Figure 15 Macrame training at Rumah Langit using OTTM's seventh configuration (Source: Pranoto, 2021).

The furniture test was carried out at Rumah Langit at the same time as the macrame training as seen in Figure 15. Through this training, we also wanted to see whether OTTM functioning as a supporting tool for making macrame was successful or not. Through this training process, it could be seen that the function of OTTM as a macrame tool was successful. However, there are several macrame knots that are more comfortable to make on the floor, according to the children of Rumah Langit, than using OTTM hanging poles, one of which is the double hitch knot.

In addition to doing macrame training, OTTM's educational function was also tested. In Figure 16, Child A, one of the Rumah Langit's pupils, can be seen playing with the dowel and rainbow stack functions on OTTM. He did this without any guidance or direction from an adult, entirely out of curiosity. These two photos prove that the Montessori concept was successfully applied in the furniture.



Figure 16 Child A playing with an educational function of OTTM.

4 Discussion

Through this research, a modular furniture unit called *OTTM (One, Two, Three, More?)* was created. With various functions available in this furniture unit we intended to make the learning process at home for children to be much easier and more enjoyable, but we also realize that this furniture is still far from perfect and that there are still some aspects that need to be reconsidered. One of them is the main feature of this furniture, which is its modularity. Although it serves many purposes, the process of changing from one configuration to another is not possible for one child to do on their own. In this case, the child needs help from

an adult, which contradicts the main concept of the design, Montessori, which wants children to be free to do activities without adult intervention.

5 Conclusion

The need for additional furniture in Rumah Langit Rusunawa Urip Sumoharjo resulted in a modular furniture design called *OTTM (One, Two, Three, More?)*, which is a Montessori-based piece of furniture that not only meets the users' physical and spatial needs but also meets the educational and creative needs of the children. This furniture was also designed to accommodate the needs of the children in the development of macrame making with the help of a hanging pole. A few weeks after the placement of OTTM at Rumah Langit, the tutors shared information about the developments and changes that had occurred since the introduction of OTTM, from visual changes, where the space has become more organized with the help of the storage function of OTTM, to the educational impact of OTTM on children. The open storage unit to store books in OTTM encourages children to take more initiative to read, and the rainbow stack and numbering dowel functions in OTTM still continue to attract the children's attention, especially children in the golden age to continue to play and be creative with them. Based on this it can be stated that OTTM as a modular furniture unit does not only act as a supporter of user activities but also as a source of activities. At the end of the research, OTTM can be declared to have succeeded in meeting the users' needs according to the author's initial expectations.

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