TOOLS FOR ENCOURAGING YOUNG CHILDREN'S IMAGINATION AND CREATIVE THINKING

BY

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โดย
ชนานาถ ลิ่มหลัก

วิทยานิพนธ์ฉบับนี้เป็นส่วนหนึ่งของการศึกษาตาม
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ได้รับการพิจารณาให้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตร

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วิทยานิพนธ์ฉบับนี้สำเร็จได้เป็นอย่างดีเนื่องมาจากได้รับความอนุเคราะห์จากอาจารย์ David Marc Shafer อาจารย์ Sridhar Ryalie และอาจารย์ธีรนพ หวังศิลปะคุณ ที่คอยให้ความสนับสนุนช่วยเหลือมาโดยตลอด กระทั้งให้คำปรึกษาและคำแนะที่ดี ช่วยให้การศึกษาครั้งนี้ผ่านพ้นอุปสรรคต่างๆ ตลอดจนการให้ความรู้ดีๆ ซึ่งเป็นประโยชน์อย่างมากในการศึกษาครั้งนี้

ขอขอบคุณคณะอาจารย์ MFA มหาวิทยาลัยรังสิตทุกท่าน สำหรับการให้ความสนับสนุนและให้ความคิดเห็นอย่างตรงไปตรงมา เพื่อช่วยให้การศึกษานี้มีความชัดเจนยิ่งขึ้น

ชนานาถ ลิ่มหลัก

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Abstract

Imagination and creativity are not talents, but it is an abstract form of thinking that is fundamental to all human beings, from which we can apply our imagination and creativity in the real world in many ways and create new results, which will spark the dream of what we will do as well as inspire many of us to live. Until we all reach adulthood, there are more responsibilities which we must face in the real world in our lives. As a result, our imagination and creativity gradually fade away. That is why people think that imagination and creativity are less important in our daily lives and are quite distant from us or sometimes only found in art or design. In fact, imagination and creativity are the matter that is very close to us and could create many benefits for us, such as helping us solve problems in various ways, and creativity also allows us to see things around us in a new light and helps to promote a cheerful, positive personality. According to various research studies, it has been revealed that the right age to foster imagination and creativity is childhood, which has a positive effect on both the body and mind.

In this creative research, the objectives were to study factors motivating imagination and creativity and to collect data to analyze the concept of designing a tool that promotes imagination and creativity for children aged 7 years and over in the form of play through the process of design and development until the prototype has been created. According to the real testing and the simulation of the use of 3D programs, it was found that new results and a variety of playing styles can also be used.

(Total 51 pages)

Keywords: Creativity Thinking, Imagination, Promoting Creativity

Student's Signature ……. Thesis Advisor's Signature ……

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หลักสูตร : ศิลปมหาบัณฑิต สาขาวิชาการออกแบบ
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บทคัดย่อ

จินตนาการและความคิดสร้างสรรค์นั้นไม่ใช่พรสวรรค์แต่อย่างใด แต่เป็นแนวความคิดที่มีรูปแบบเชิงนามธรรมซึ่งเป็นแนวคิดพื้นฐานที่มีอยู่ในตัวมนุษย์เราทุกคน โดยเราเองนั้นสามารถนำจินตนาการและความคิดสร้างสรรค์ของเราไปใช้ในโลกแห่งความเป็นจริงได้อย่างหลากหลายวิธีและสร้างผลลัพธ์ใหม่ๆ อยู่เสมอซึ่งจะช่วยในการจุดประกายความฝันในสิ่งที่เราจะทำ เช่นเดียวกับการสร้างแรงบันดาลใจมากมายในการใช้ชีวิต จนกระทั้งเมื่อเราทุกคนนั้นเติบโตถึงวัยผู้ใหญ่มีความรับผิดชอบและหน้าที่มากขึ้น ซึ่งในการที่เราจะต้องเผชิญกับโลกที่เป็นจริงมากขึ้นในชีวิต ส่งผลให้จินตนาการและความคิดสร้างสรรค์ของเราค่อยๆ จางหายไป นั่นเป็นเหตุผลที่ผู้คนคิดว่าจินตนาการและความคิดสร้างสรรค์มีความสำคัญน้อยลงในชีวิตประจำวันของเราและค่อนข้างห่างไกลจากตัวเราหรือในบางครั้งอาจพบได้เฉพาะงานศิลปะหรือการออกแบบ แต่ในความจริงแล้วนั้นเป็นเรื่องที่ค่อนข้างที่ใกล้ตัวเรามากและสร้างคุณประโยชน์ที่มากมายให้แก่ตัวเรา อาทิเช่น ช่วยแก้ปัญหาในเชิงสร้างสรรค์ในรูปแบบต่างๆ อีกทั้งความคิดสร้างสรรค์ยังช่วยส่งเสริมให้เรานั้นสามารถมองเห็นสิ่งต่างๆ ที่อยู่รอบตัวในมุมมองที่ใหม่มากขึ้น และรวมถึงช่วยส่งเสริมบุคลิกภาพในเชิงบวกที่ร่าเริงสดใส จากงานวิจัยต่างๆ พบว่าวัยที่เหมาะสมในการเสริมสร้างจินตนาการและความคิดสร้างสรรค์ในเด็กจะส่งผลดีต่อทั้งร่างกายและจิตใจ

ในงานวิจัยนี้เป็นการวิจัยเชิงสร้างสรรค์ที่มีวัตถุประสงค์เพื่อศึกษาปัจจัยที่กระตุ้นและรวบรวมข้อมูลเพื่อวิเคราะห์แนวคิดในการออกแบบเครื่องมือที่ส่งเสริมจินตนาการและความคิดสร้างสรรค์สำหรับเด็กอายุที่ตั้งแต่ 7 ปีขึ้นไปในรูปแบบของการเล่น โดยผ่านกระบวนการออกแบบและพัฒนาจนกระทั้งได้สร้างตัวต้นแบบ โดยผลที่ได้ทำการทดสอบใช้งานจริง และทำการจำลองโดยการใช้โปรแกรมสามมิติพบว่าได้ผลลัพธ์ที่แปลกใหม่และรูปแบบการเล่นที่ค่อน ข้างมีหลากหลาย รวมทั้งสามารถใช้งานได้จริง

(วิทยานิพนธ์มีจำนวนทั้งสิ้น 51 หน้า)

คำสำคัญ: ความคิดสร้างสรรค์, จินตนาการ, ส่งเสริมความคิดสร้างสรรค์

ลายมือชื่อนักศึกษา ..... ลายมือชื่ออาจารย์ที่ปรึกษา .....

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Chapter 1

Introduction

1.1 Background and Significance of the Problem

From the past to the present, human beings have used creativity to play a role in many lives, whether it is culture, lifestyle and facilities with many things arising from the imagination of people in the past will continue to inspire and push people today to extend their imagination to creative ideas.

The definition of imagination is the ability to produce images in the brain that may not be perceived through sight, hearing or other senses. That can be considered as an important aid in piloting knowledge into practical applications. In terms of creativity, it is different. Creativity is that human beings have the ability to piece together the meaning of things through sensory perception and experience in a way that relates various information within the brain are analyzed to produce new and different results, which by human creativity and good imagination will bring many benefits for example help us to develop the potential of the brain, make us more intelligent, witty, sharper because the brain has more flexible work and also helps to more open and neutral learning mindset, It helps to be ready to cope with changes and find new aspects and ways of living with new ways to solve problems, Increases positive emotions, reduces stress and invigorates life.

In this research, the context that helps people's creativity in modern times is studied to obtain interesting datasets that can be further developed and applied in design work. In this work process, it is necessary to study the process that stimulates imagination and creativity, as well as to study the concepts of human beings in each age group whether they are different or not and what factors affect changes and collect data

According to the results of a study to test creativity (Land & Beth, 1992) as in Figure 1.1 below, in a longitudinal test of creative, NASA study found that of 1,600 children's 5 years old got 98 percent scored at "Creative Genius Level". Five year later in the same group of children got 30 percent and five years later again have only 12 percent and when the same test with 280,000 adults (31 year). This shown that creativity can tend to decline while we have to learn and face more of the real world and what if creativity persists with us and can adapt this applicable to life in the future.

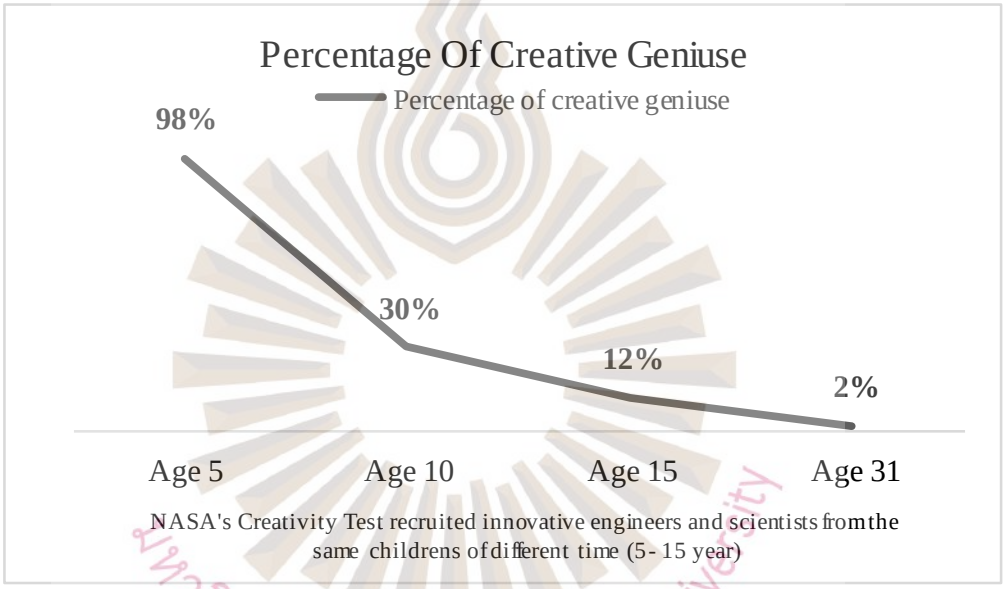


Figure 1.1 Test results from NASA's Creativity test recruited innovative engineers and scientists form the same children at different time (5,10 and 15 year) compared to adults (31 year)

Source: Land & Beth, 1992

1.2 Research Objectives

1.2.1 To study the factor to stimulate imagination and creativity.

1.2.2 To study the design process of tools that promote the development of the imagination and creativity.

1.3 Research Methodology

The method of conducting the research is as follows.

1) Researching and collecting information related to promoting the development of children's imagination and creativity.

2) Data analysis

3) Thinking process in design and development.

4) Materials used to create designs.

5) Observe, record images, experiment for actual use in order to study and analyze the relationship to encourage creativity and imagination with the design work.

1.4 Research Framework

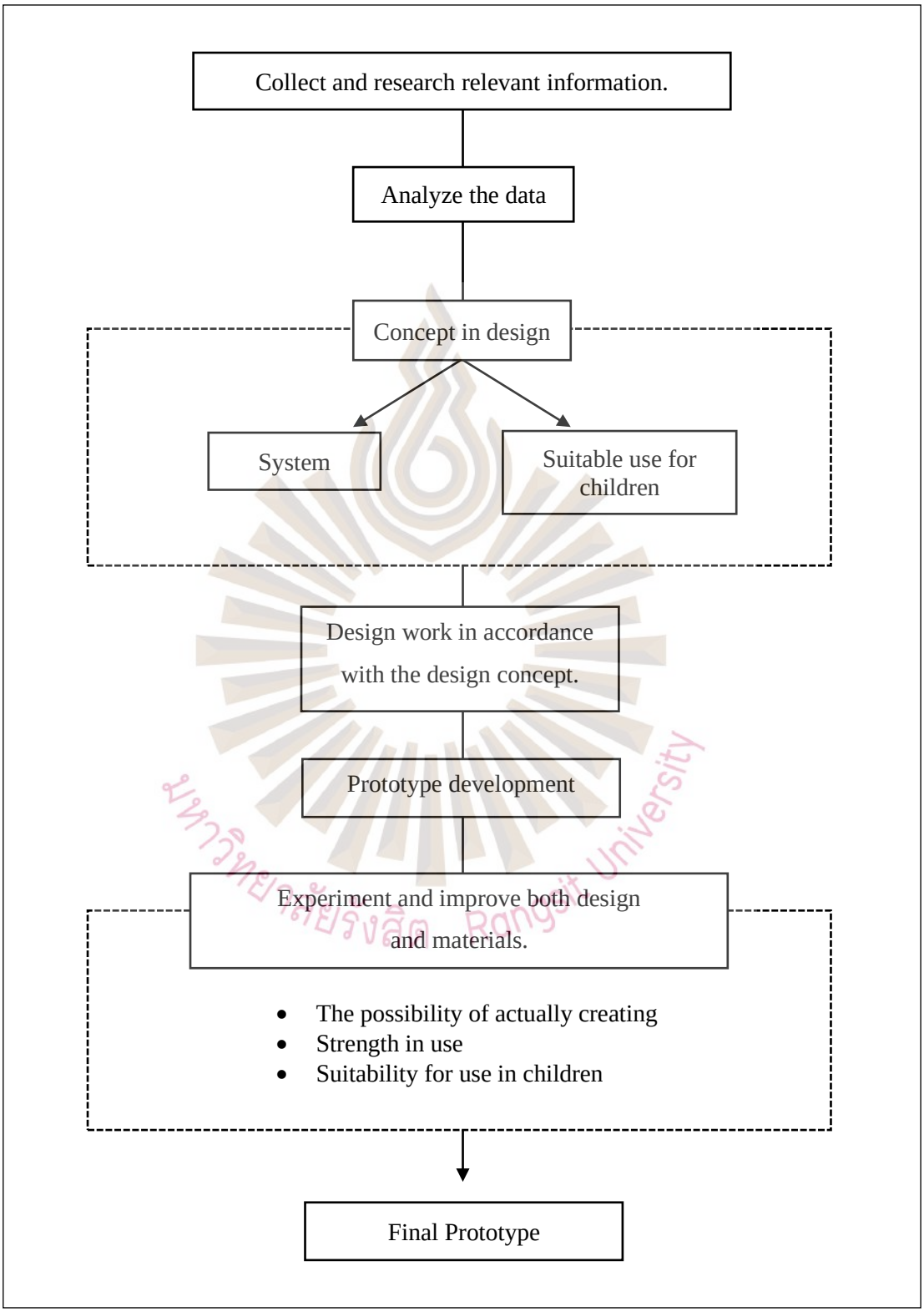


Figure 1.2 Research Framework

Chapter 2

Literature Review

2.1 Cognitive development

Jean Piaget's Theory of Cognitive Development proposes that children go through four distinct learning stages. The theory understands how children acquire knowledge at different ages.

The first phase Sensorimotor range from birth to 2 years, are able to perceive through movement and senses by learning through basic physical actions such as grasping, looking, and listening, the next stage is the Pre operational stage, from 2 to 7 years old their able to use pictures to represent objects Concrete operational stage Ages 7 to 11, The key features and developmental changes in this stage are: Beginning to think logically about concrete events Beginning to understand concepts of conservation There will be more logical and organized thinking but it's still very concrete. In Formal operational stage, age 12 and older, begins to think abstractly and reason about hypothetical problems, thinking more about moral, philosophical, ethical, social, and political issues (Cherry, 2022). as in Table 2.1

This section should provide enough detail to allow full replication of the study by suitably skilled investigators. Protocols for new methods should be included, but well-established protocols may simply be referenced.

Table 2.1 Jean Piaget's Theory of Cognitive Development proposes that children go through four distinct learning stages.

No.	Stage	Age	Cognitive development
I.	Sensorimotor	Birth-2 years	❖ Know the world through movements and sensations. ❖ Learn about the world through basic actions such as sucking, grasping, looking and listening. ❖ Learn that things continue to exist even when they cannot be seen. (Object - permanence) ❖ Realize that they are separate beings from the people and objects around them. ❖ Realize that their actions can case things to happen in the world around themselves.
II.	Pre-operational	2-7 years	❖ Beginning to think symbolically and learn to use word and pictures to represent objects. ❖ Tend to be egocentric and struggle to see things from the perspective of others. ❖ Getting better with language and thinking but still tend to think in concrete terms.
III.	Concrete operational	7-11 years	❖ Beginning to think in logically about concrete events. ❖ Understand the concept of conservation; for example, thinking that the amount of liquid in a short is wide cups equal to that in tall. ❖ Thinking becomes more logical and organized but still tend to think in very concrete terms.
IV.	Formal operational	12 years up	❖ Beginning to think abstractly and reason about hypothetical problems. ❖ Beginning to think more about moral, philosophical, ethical, social and political issues that require theoretical and abstract reasoning. ❖ Beginning to use deductive logical or reasoning from a genital principle to specific information.

Source:Cherry, 2022

2.2 Creativity

Torrance said, “Creativity is defined as a process in which a person is sensitive to problems, flaws, gaps in knowledge, missing or inconsistent, and sensitive to discernment and finding solutions. problem solving sensitive to guesses or assumptions about defects Test and retest the hypothesis until finally the results can be shown to others.”

Gilford said, “Creativity is the brain's ability to think in multiple directions. which can start fluency in thinking flexibility in thinking and the ability to compose and give new explanations that follow the logic to find just one correct answer. But the most essential element of creativity is originality. Creativity is not a talent that a person has but it is a quality that exists in a person, which is not equal and individuals manifest themselves at various levels.”

2.2.1 Components of Creative Thinking

The four components of creative thinking as follows (Guilford, 1967)

1) Fluency in thinking means producing many ideas in a brief time. Then choose the best ideas to solve problems, including the ability to change the direction of thinking as well.

2) Flexibility in thinking means finding multiple approaches to solve a problem instead of using only one approach by analyzing the problem from multiple perspectives.

3) Initiative means finding innovative approaches or different methods, including different ideas, may be caused by adapting prior experience and knowledge.

4) Elaboration means analyzing concepts until examining details more clearly.

2.2.2 Creative Process

The traditional Four Stages of the creative process by the theory of Wallas, 1962 (Skillicorn, 2021).

1) Preparation It is collection or identification of problems that arise.

2) Incubation The process of cleaning up the information obtained.

3) Illumination The process of arranging and connecting ideas until they become clear images.

4) Verification Testing and proving opinions.

2.2.3 Basic types of creativity

Creative insights can be the result of two processing modes, deliberate and spontaneous, each of which can guide neural computation in structures that contribute emotional content and in structures that supply cognitive analysis. Crossing the two processing modes with the type of information yields the four basic types of creativity shown as in Figure 2.1 below. (Dietrich, 2004).

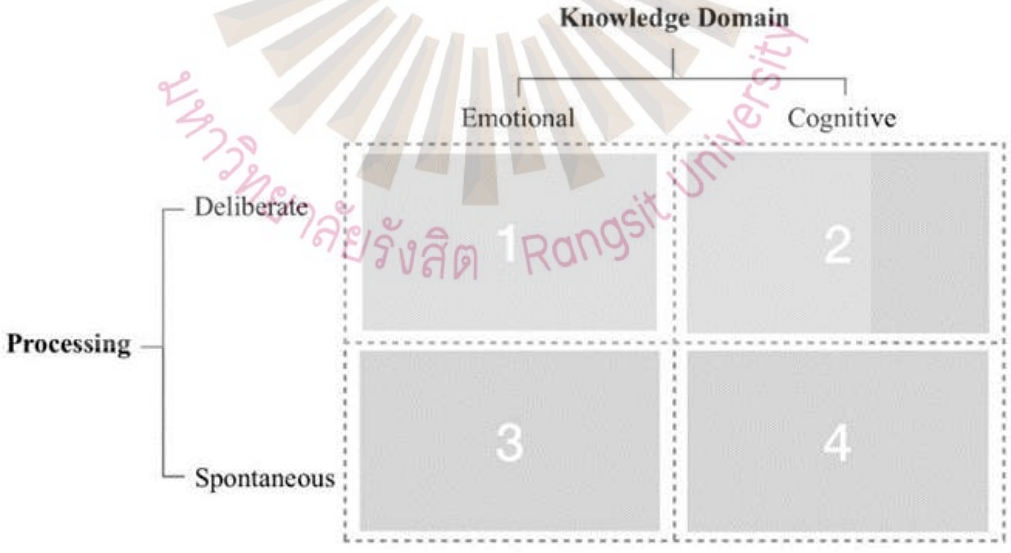


Figure 2.1 Type of Creativity (Deliberate mode–cognitive structures, Deliberate mode–emotional structures, Spontaneous mode–cognitive structures, Spontaneous mode–emotional structure)

Source: Dietrich, 2004

2.2.4 Variables effect to children's creativity

Based on the results of the Friedman's assessment of the factors of creative effectiveness of children using the test, the effect of each factor on children's creativity differs, shown in Table 2.2 Shows the top 5 variables with the highest score: motivation to play, Innovation, environmental survey, relaxing the mind and imagination of the child. In section the lowest scores 5 variables were familiarity with the original conditions, competition, pressure, number of children in the family and the gender of the child (Azeri, Reza Parvizi, & Hosseini, 2015).

From the above research, it is interesting to reveal that the most influencing factor affecting creativity in children is the motivation for playing. Therefore, the researcher is interested in focusing on the playing system that sends creativity.

Table 2.2 Ranking the effective factors in children's creativity (questions of the questionnaire) by Friedman's test.

Rank	Effective factors in children's	Mean ranks
1	Motivation to playing	41.74
2	Innovation	40.89
3	Exploration in the environment	39.91
4	Mental relaxation of the child	37.60
5	Imagination	37.46
46	Getting used to the condition	11.71
47	Competition	11.68
48	Pressure	9.83
49	No. of children in the family (home)	9.27
50	Child's gender (boy or girl)	5.70

Source: Azeri et al., 2015

Chapter 3

Research Methodology

3.1 Target Group of Study

According to the foundation of Piaget's theories, children in the Concrete Operational Stage of Cognitive Development have a fairly good use of inductive logic, that is, to make connections from specific experiences to general principles. The ability to focus on multiple parts of the problem and another important development at this stage is the ability to think backwards, a key step towards higher-level thinking. (Scott & Cogburn, 2023)

This stage of cognitive development also serves as an important transition between the preoperational and formal operational stages in cognitive development which competence increases manipulating mental information and start thinking about other people's thoughts will play an important role in the formal process of development when logic and abstraction continue so in the concrete operational stage up or aged 7 years or more the term is very important in the formal process, the researchers think it is suitable states for children that we can use to promote development and nurture both imagination and creativity.

3.2 Research Instruments

Observation is one method used as a tool for collecting research data by using the observer's senses by recording the observations from the collection of data generated from testing the product after the prototype is completed. by analyzing the data and summarizing the results the researcher will make a participatory observation, that is, the observer participates in testing the actual use of the product by himself.

3.3 Data Collection

In this additional 4 of case study that collecting and exploring both children's toys, household appliances, tools, and everyday objects to study the functions and various working systems that may affect to encourages imagination and creativity shown in below Figure 3.1, 3.2, 3.3 and 3.4

1) Chewp's practical cooking set that assit to real cooking, allow children get real experiences and real material. Being able to experience real situations helps children to know how to be learning and dealing with problems better including integrating cooking skills with toys to inspire children in future careers and activities.

Figure 3.1 Chewp, Toy cooking set, design by Bat Chen

Source: Turner, 2013

2) Animate's creative DIY robot kit for children between the age of four to eight who want to bring their imagination to life through technological construction. Each electronic element was size and color to make the construction process more approachable against other children's toy. Additionally, the robot's components and modules can be switched out for one another to enhance and diversify interactions between the creator and finished cardboard-mechanical toy.

Figure 3.2 Animate, Design by Studio Fantasio x OPPO

Source: Kowal, 2020

3) Deku’s modular furniture building system composed of wooden planks that fasten together at the planks’ 45-degree, pyramid-shaped edges. This triangular building system is essentially what allows for so many different configurations and shape then use colorful masking tape to fasten each module together It encourages creativity by conveying ideas quickly and resulting in more novel results.

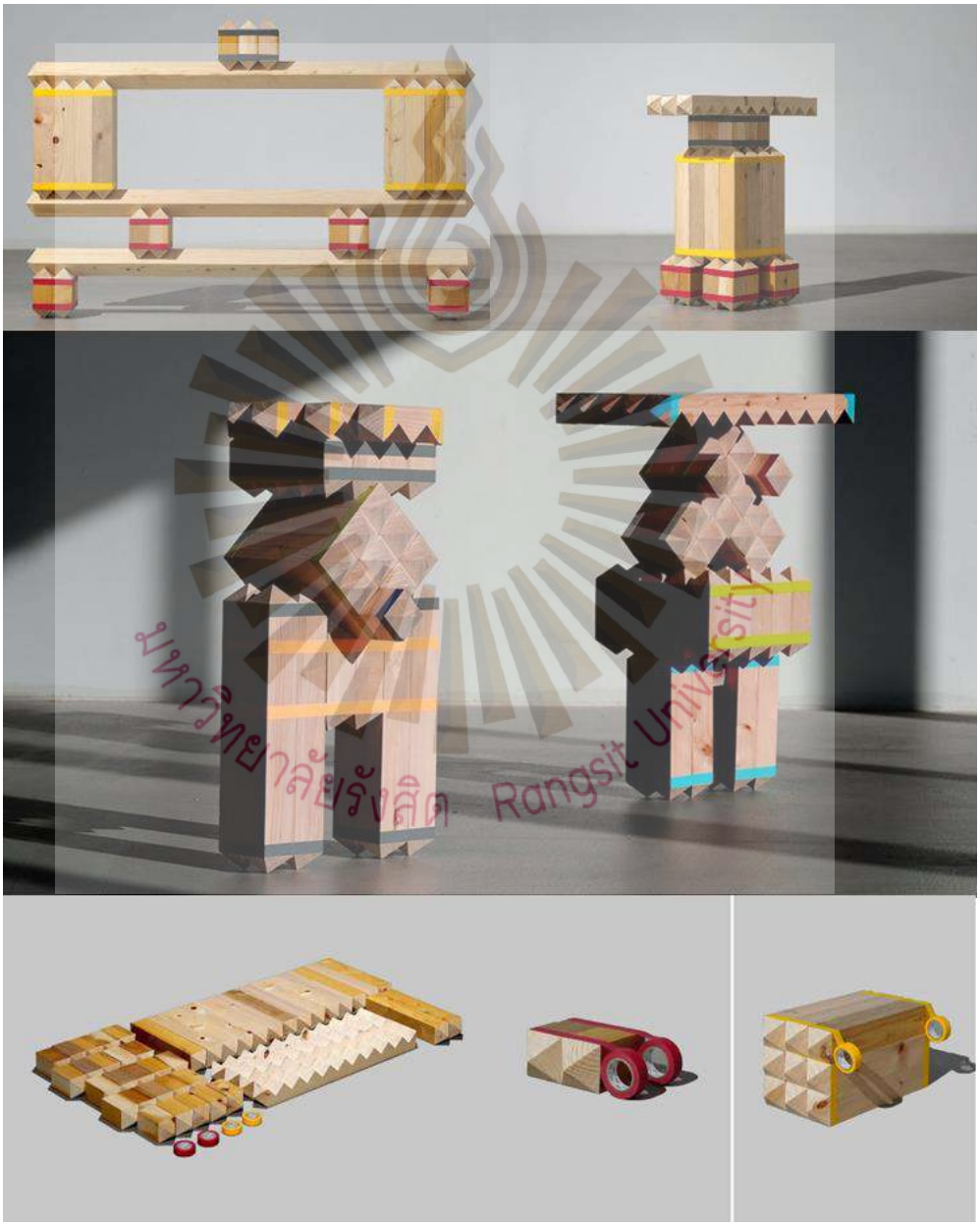


Figure 3.3 Deku, Design by Takuto Ohata

Source: Kowal, 2022

4) The toys for ages 6 plus, purchased from a general toy store, there are 48 triangle-shaped pieces that can be rotated, colorful, attractive to children as well. The results of the experiment found that it was quite difficult and took a long time to be able to come out with different appearances.

Figure 3.4 Toys for ages 6 plus.

Source: Researcher

3.4 Data Analysis

The Design Concept

From the study of the mentioned case studies shown in Table 3.1 below, it was found that the mechanisms and systems of both toys and utensils are interesting, free to play, encourage creativity, can actually be used, help enhance the skill of assembling things and systematic thinking skills, there is a good use of colors and appearances that attract children's attention.

Table 3.1 Summarize case studies.

No.	Name	Category	Appearance	Interesting key points
1	Chewp	Toy cooking set	- Wooden cooking utensil, there is a curve that looks safe for children.	- Let children get real experiences and real content so that children can learn to better solve problems in life.
2	Animate	Toy	- Colorful - It is a piece made of cardboard that can be assembled into an electronic device.	- The pieces of electronic equipment are of color and size that are easy to identify and use, let children be able to disassemble or assemble the robot creatively and freely.
3	Deku	Furniture	- Several geometric pieces can be put together.	- The shape of the parts is relatively simple - Can be quickly assembled into different shapes.
4	Toy for ages 6 plus, (purchased from a general toy store)	Toy	- Colorful - 48 triangle pieces that can rotate freely.	- There are colors that look bright. - The shape is simple and can be rotated freely into different shapes.

The researcher has an idea to create a tool to help stimulate the imagination and creativity in children, so the design principles must be considered into 2 issues as follows.

1) System that Enhances Imagination and Creativity.

1.1) Functionality of various applications, has wider benefits.

1.2) Use of colors and shapes to attractive for fosters imagination and creativity.

1.3) Simple shape not too complicated, enables children to express their ideas quickly.

1.4) Hands-on with real materials to get acquainted with experience in physical and mental realism.

2) Suitable Use for Children

2.1) The size and weight are appropriate that children can hold it by themselves.

2.2) Usage that is not too complicated.

3.5 Thinking process in design and development

The researcher has designed Develop work and test the design until the prototype has been produced in all 4 sequences (The first sketch idea, Stage 1st development, Stage 2nd development, Stage 3rd development) as follows:

3.5.1 The first sketch idea

Based on this concept, the researcher concluded the first idea of finding a way to connect to achieve various outcomes and a method that is not too complicated. Therefore, it starts from sketching various types of images that lead to methods for connecting from sheet to sheet so that they can be combined vertically and horizontally until they can become three-dimensional objects as shown in the sketch of the idea in Figure 3.5, 3.6 and 3.7 as the next page.

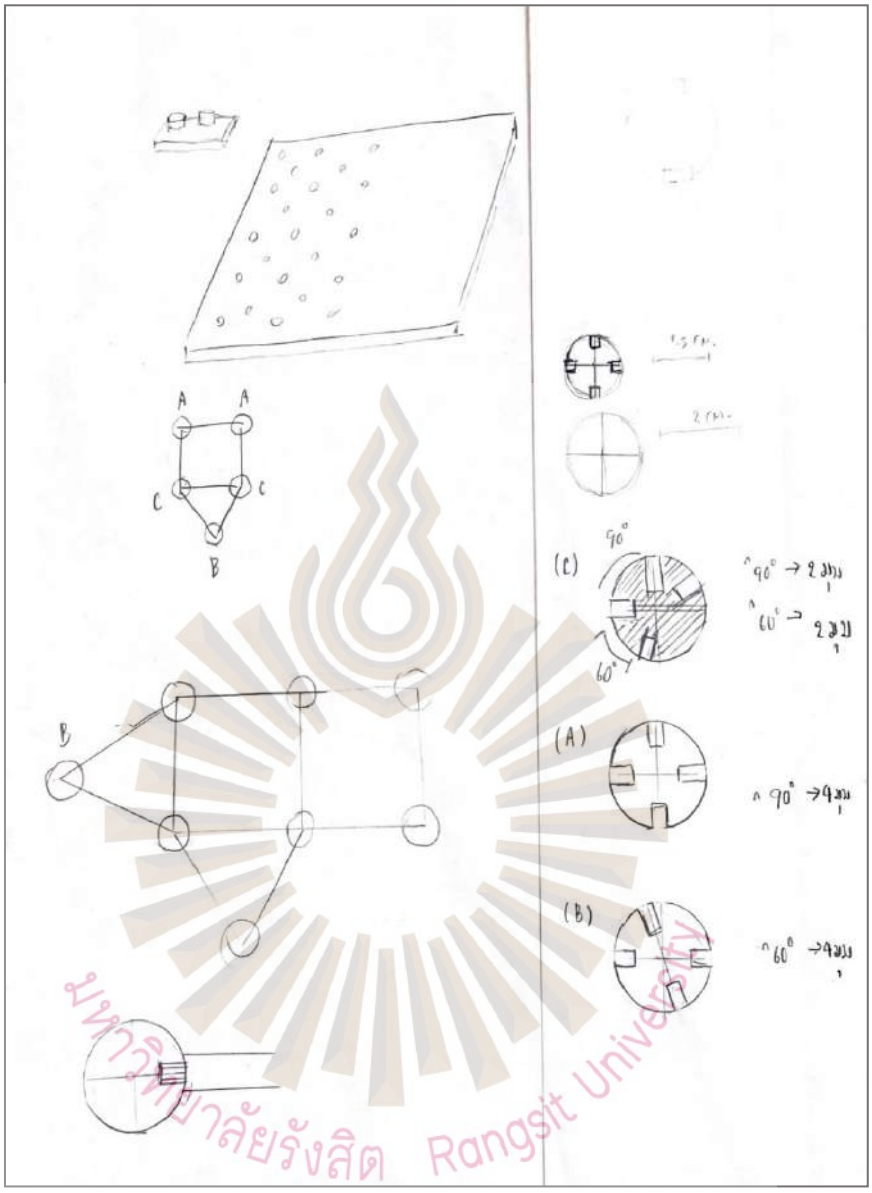


Figure 3.5 The first sketch idea 01.

The connection of corner-to-corner connections with a pole to connect the sheets There are 3 forms in total, namely A, B and C, which differ in degrees of angles as follows.

A – There are 4 corners, each corner is 90^{o}.

B – There are 4 corners, 60^{o} each.

C – There are 4 corners, 60^{o} and 90^{o} each.

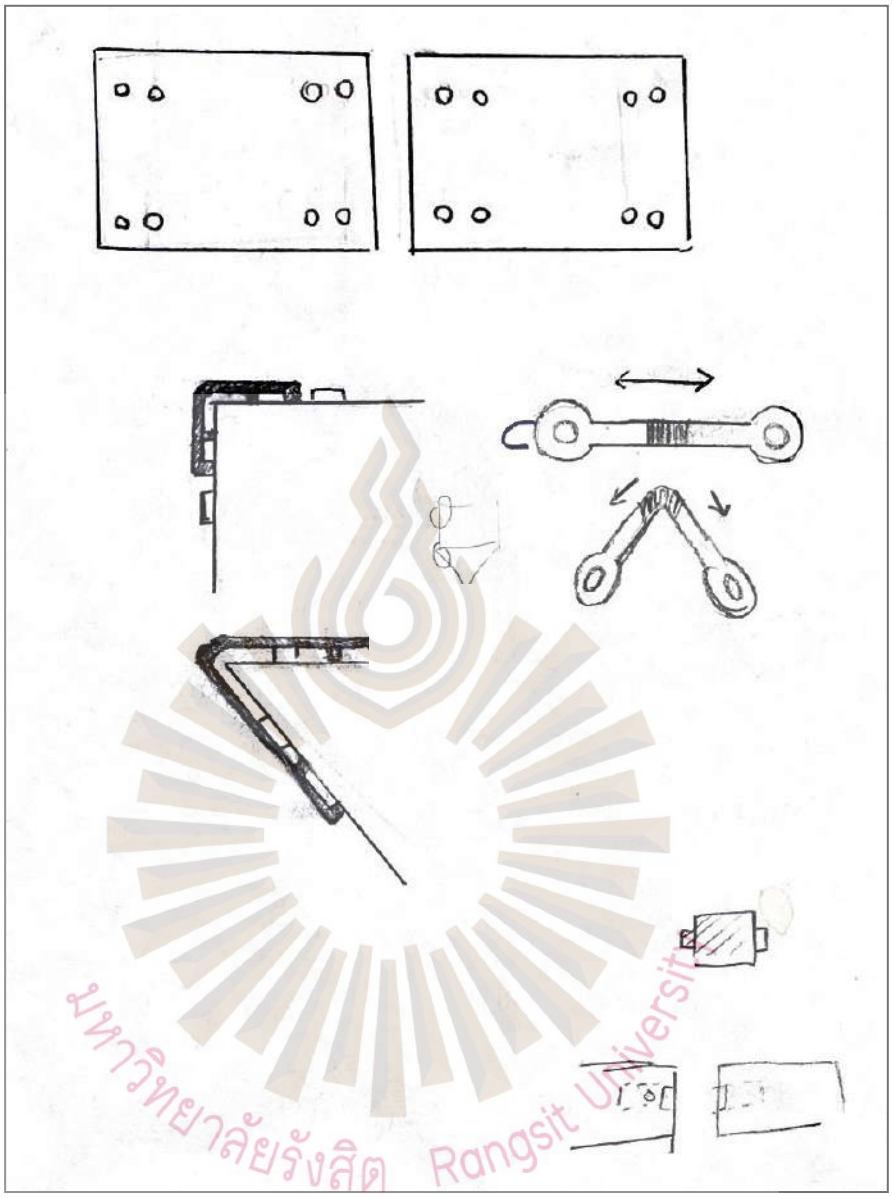


Figure 3.6 The first sketch idea 02.

In the sketch, idea 2 is a seam with a flexible material. The angle of the angle can be adjusted by moving the lock position to a larger distance to allow the material of the connector to be tensioned, resulting in a smaller angle, which is useful for adjusting the angle resulting in a more dimensional connection.

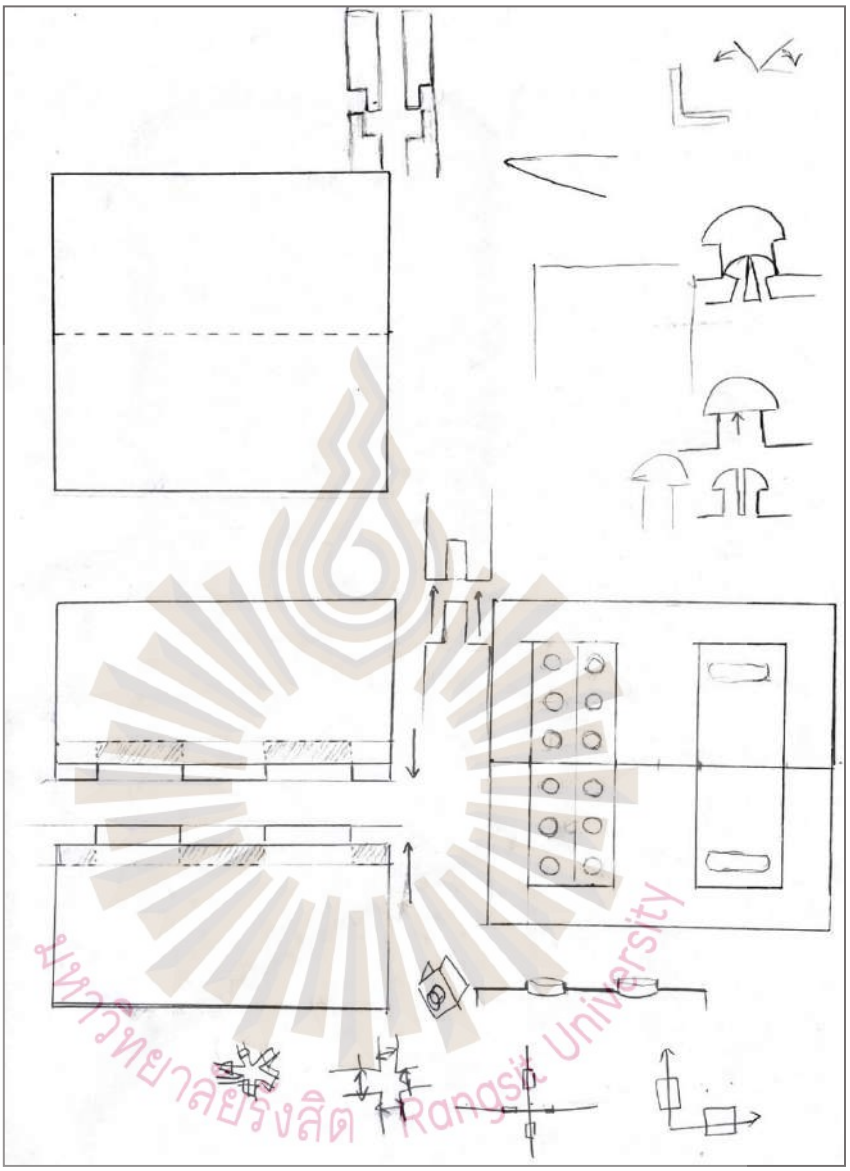


Figure 3.7 The first sketch idea 03.

In this Idea 3 sketch, there is a solid bonding method with an emphasis on strong joints both horizontally, vertically, and cornering. The splice together with the slot size of the connector must fit the button over there of the plate.

3.5.2 Stage 1st development

This sketch is another idea that the developer tries to connect the shapes together using a modular system because they want to strengthen them, but there are limitations in many ways, whether it is a form of connection that is not too independent and complicated as shown in Figure 3.8

Figure 3.8 Sketch idea 01 in stage 1st development.

Later, the shape was modified to be simpler by giving a square shape and adding holes between the panels for more functionality so that it could be assembled together by being further strengthened with pins to lock everything together as shown in Figure 3.9 (3D images, simulating the 1st stage development model) below. The researcher has built a model, the sequence of steps in building is as follows.

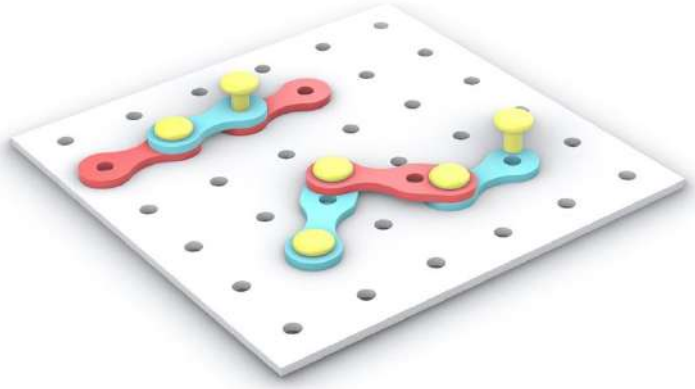
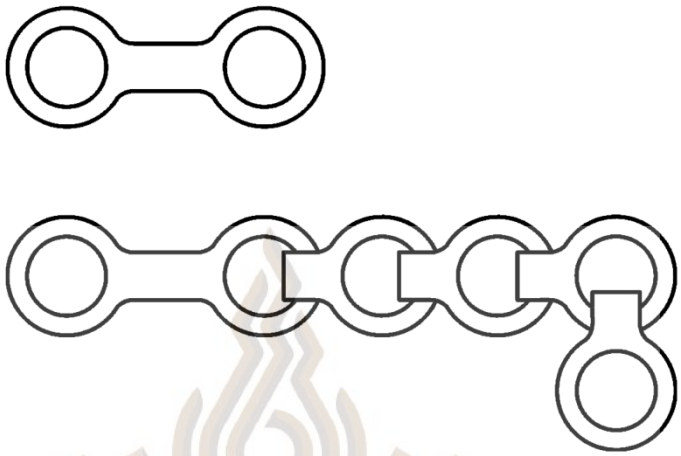


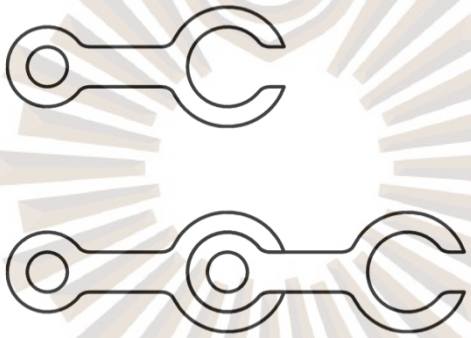
Figure 3.9 3D Images, Simulating the 1st stage development model.

1) In the first step, the researcher started from the design and sketch the appearance of the connector as shown in Figure 3.10 (A, B and C).

A.



B.



C.

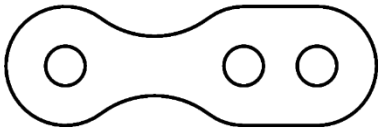


Figure 3.10 Sketch the appearance of the connector in the stage 1st development.

2) In this part, 3D prints a model of a 9x9 centimeters, 5 millimeters thick. In panel with 9 holes, pins and connectors for the next step in the silicone casting.

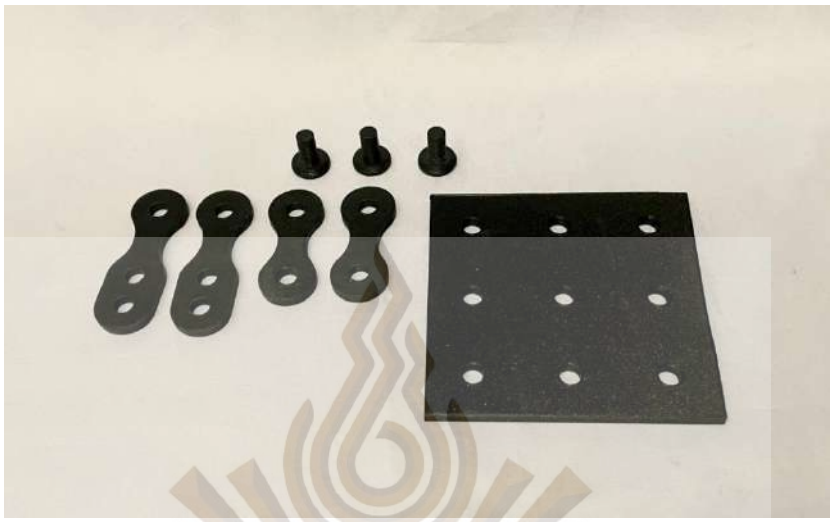


Figure 3.11 3D Prints Model (Panel, Connectors and Pins).

Source: Researcher

3) In this part, the 3D prints model is used to cast the silicone for the connector mould, leaving it to dry for 1 day and then removing the 3D prints model body. The next process is to mix the silicone with the desired colour and apply the printed Vaseline all over to prevent the silicone from sticking to the print. Pour the silicone and wait for it to dry for 1 day as shown in Figure 3.12 below. So, connector body is made of silicone material for flexibility and strength.

Figure 3.12 Process of mold casting and making connectors.

Source: Researcher

3.5.3 Stage 2nd development

In the second stage of development, it is considered that the size and material of the connector are still not suitable for the load therefore, the appearance of the connector has been improved to be larger and the material is made of plastic to increase strength.

There are 4 appearances and functions that different

1) Vertical and horizontal connectors.
2) A gap that closes the gap between the panels.
3) Scene
4) Hinge

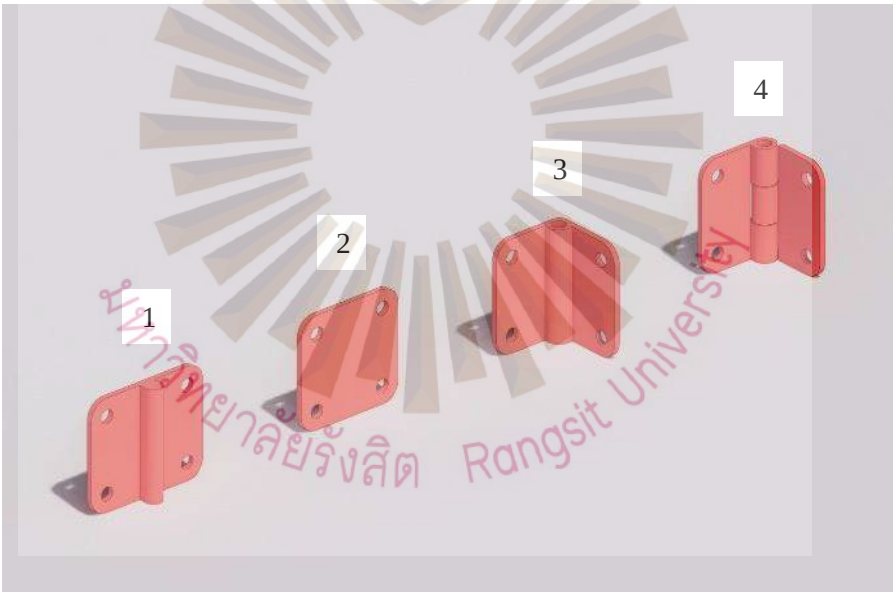


Figure 3.13 Connector in second stage of development.

The panel features have been adjusted to be larger (20x40, 40x40, 60x40 centimeters), 5 millimeters thick and more shapes such as triangles, circles in different sizes that shows various details of the panel including other assembly parts as shown in Figure 3.14 and 3.15 below.

Detailed pictures 01

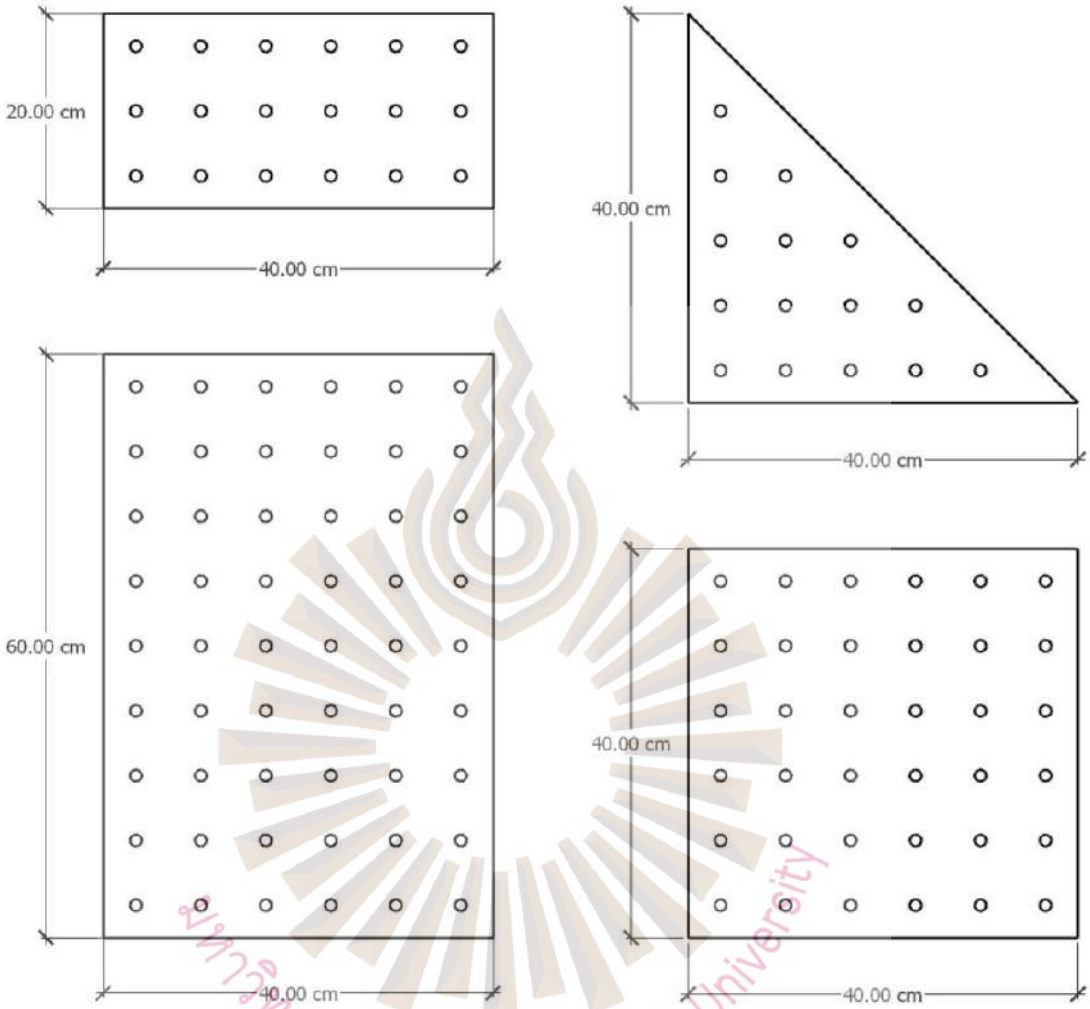


Figure 3.14 Detailed pictures 01 (sizes of panels).

Detailed pictures 02

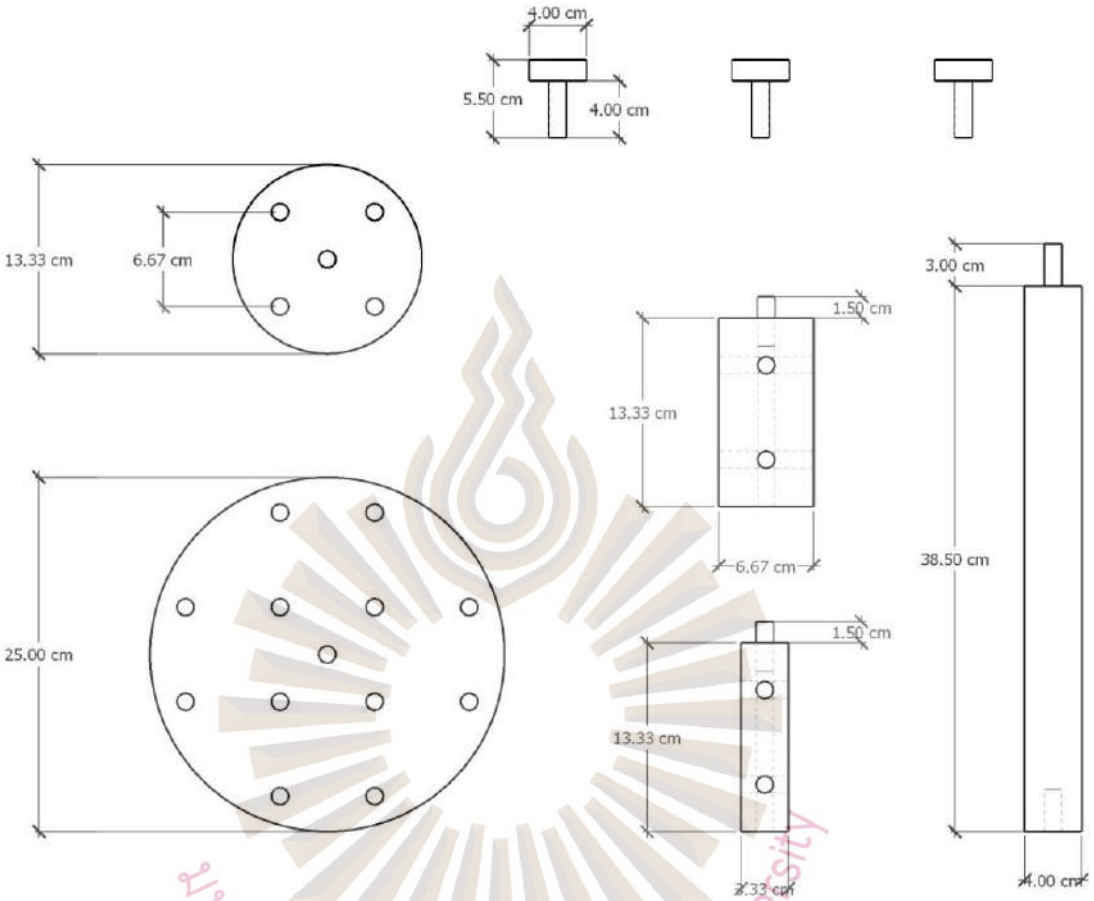


Figure 3.15 Detailed pictures and sizes of other parts include pins.

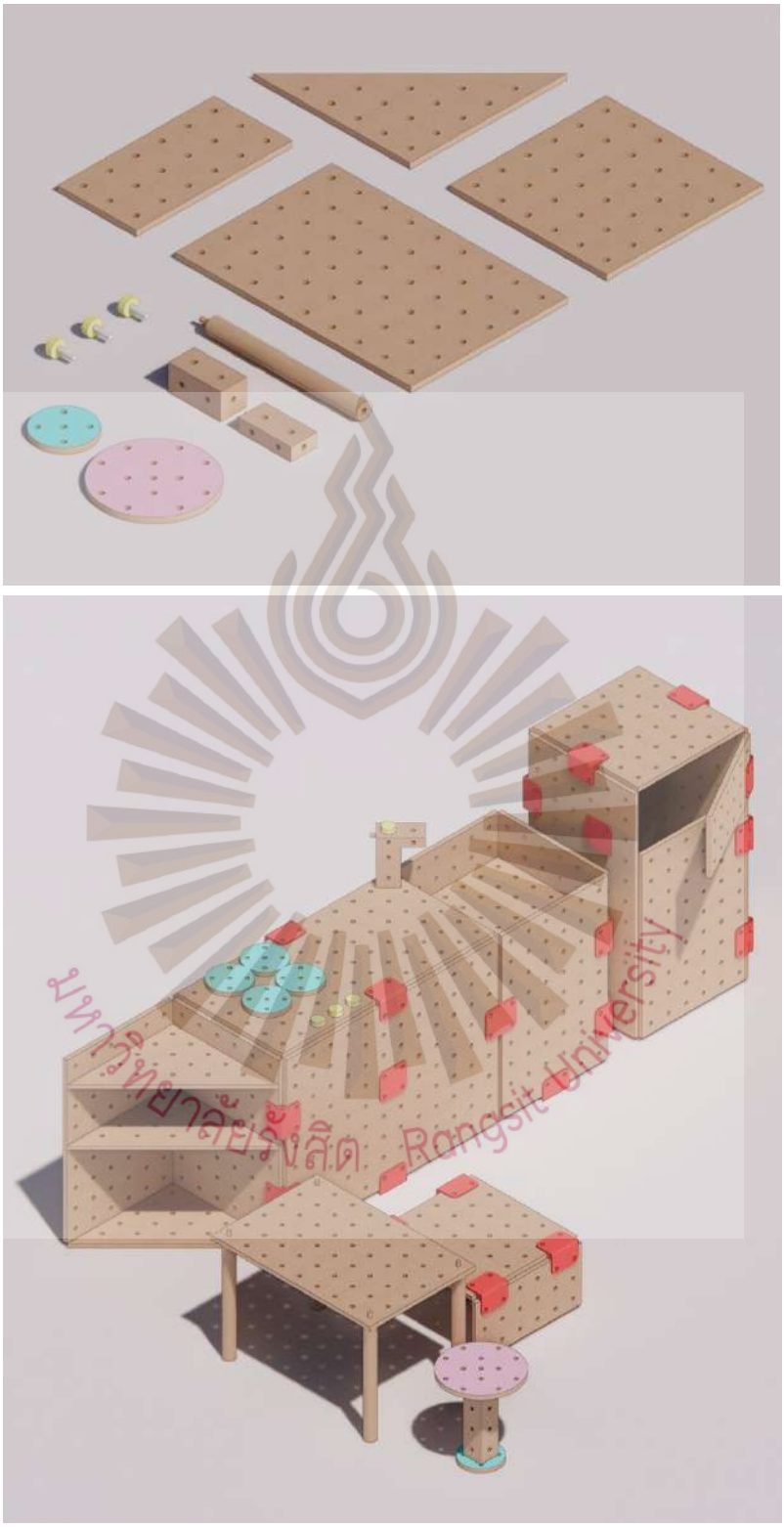


Figure 3.16 3D Images, Simulating the 2rd stage development model (Kitchen set).

3.5.4 Stage 3rd development

Later, the 3rd development design, modified the position and hole pattern of the new plate to allow for multi-directional assembly and more freedom. Later, the appearance of the control panel was redesigned and change the pins to screws, which makes it easy to assemble and design of the rotation cycle not too much to suit the strength of the child in Figure 20 below.

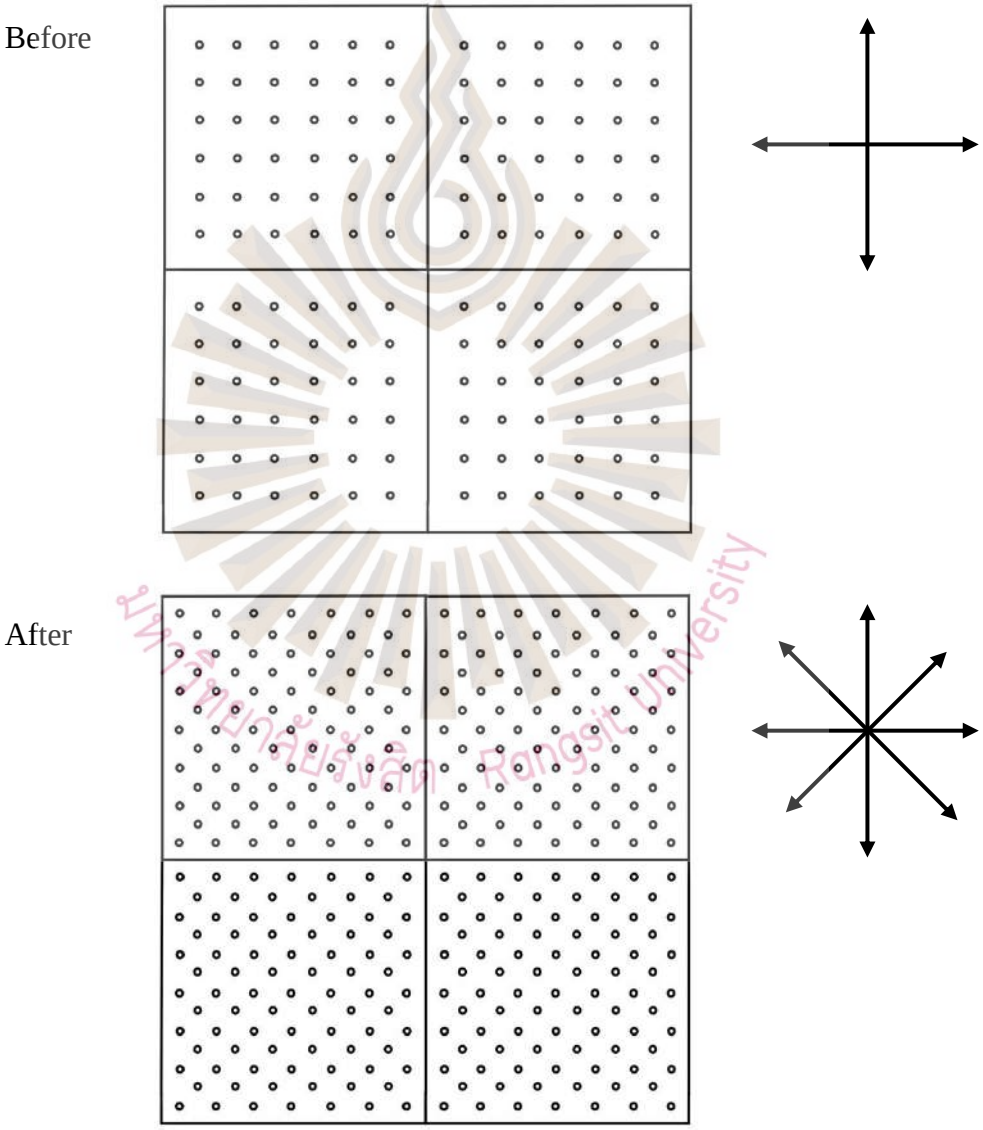


Figure 3.17 Comparison of hole position patterns before and after design development in relation to directional freedom.

3.6 Prototyping Process

There are 4 main parts: wood panel, screw, connector and decoration part.

3.6.1 Panels

Panels are made of lightweight pine wood material will have a thickness of 10 mm. which is quite safe for children to assemble in different sizes and shapes as shown in Figure 21 below.

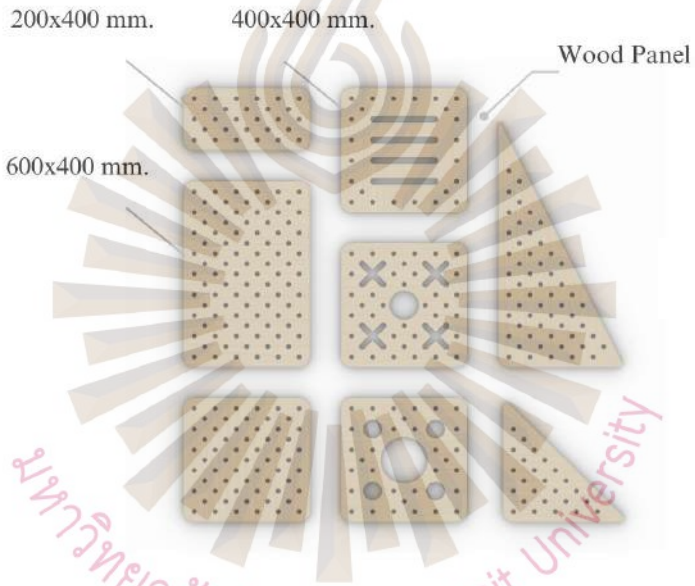


Figure 3.18 Various parts in the work have wooden panels.

Figure 3.19 Pine Wood.

3.6.2 Screws

The screw, it is a 3D-printed plastic material designed to be easy to hold by adding surface texture, so there are 7 shapes in total, each with different functions, allowing children to expand their imagination and the important thing is the number of turns to rotate the screw is not more than 10 times for reduce the assembly time and suitable for children's strength as shown in Figure 3.20 below.

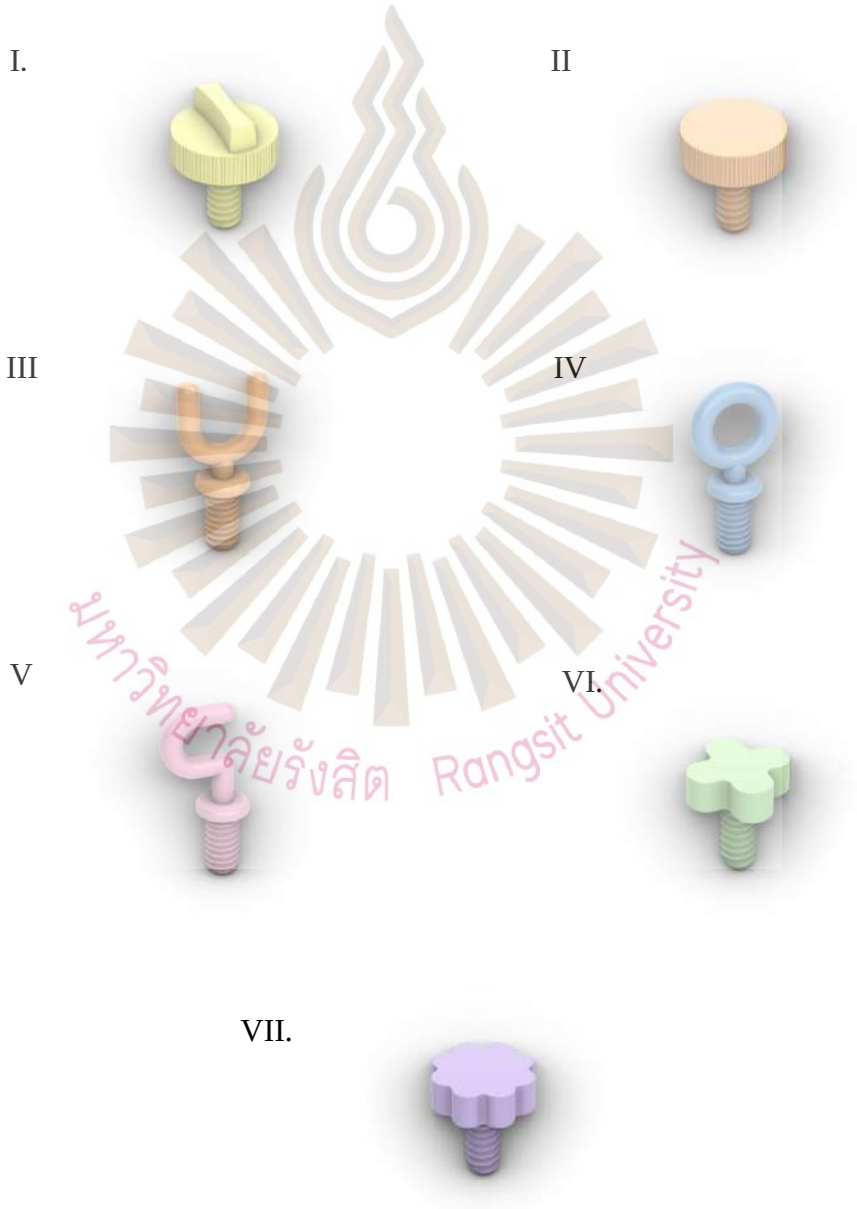


Figure 3.20 Screws (3D model).

1) Screw details (Side view)

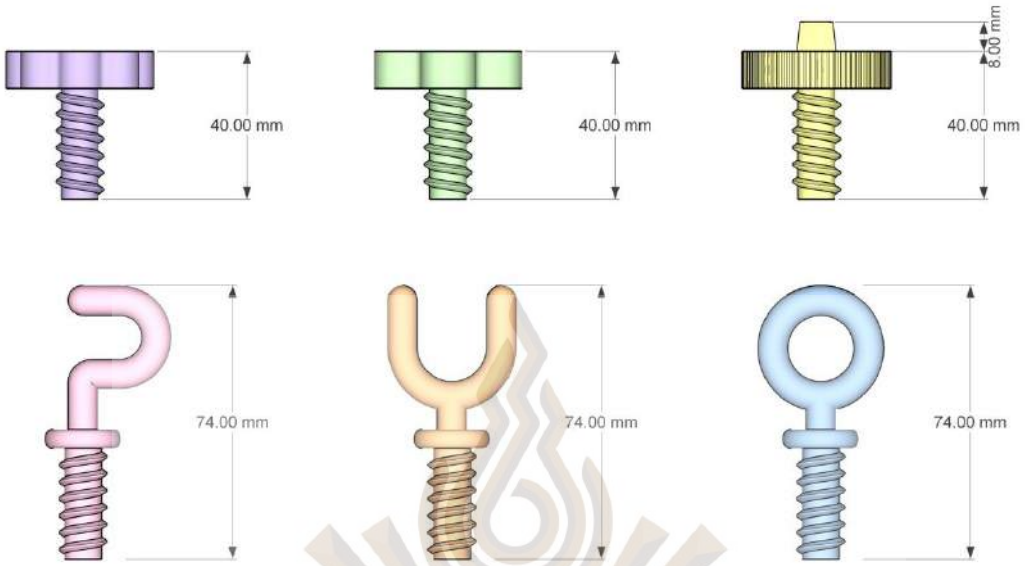


Figure 3.21 Screw details of side view (3D model).

2) Screw details (Top view)

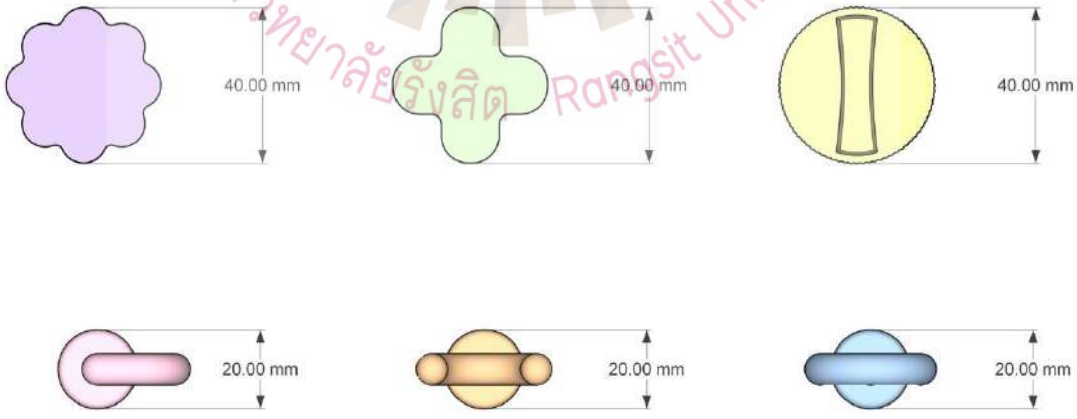


Figure 3.22 Screw details of top view (3D model).

3.6.3 Connectors

There are a total of 3 types of connectors with different functions. In the design, there are color inserts that help children to identify the types of connectors more easily as in Figure 26.

A. Flat: Vertical and horizontal connectors between two panels.

B. race: The Brace allows the connection to look more dimensional and improved the pattern to stronger also can certify the actual use.

C. Hinge: The hinge makes the panel open and close, which makes it more useful when playing.

A.

B.

C.

Figure 3.23 Connectors (3D model).

1) Connectors (Side view)

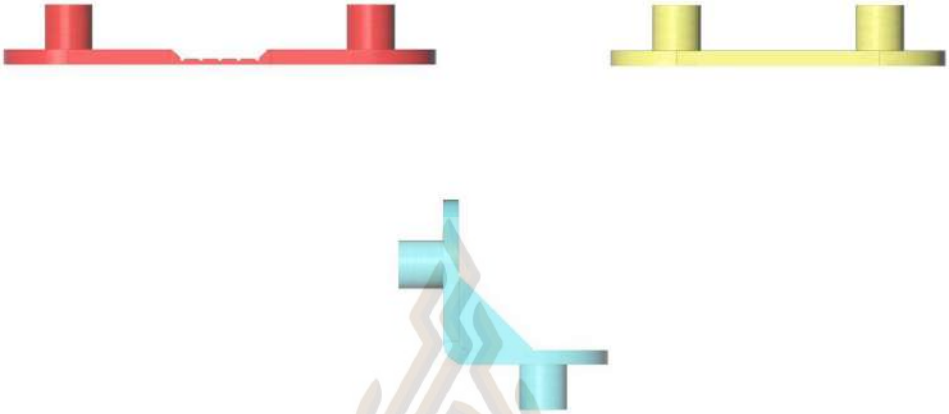


Figure 3.24 Connectors side view (3D model).

2) Connectors (Top view)

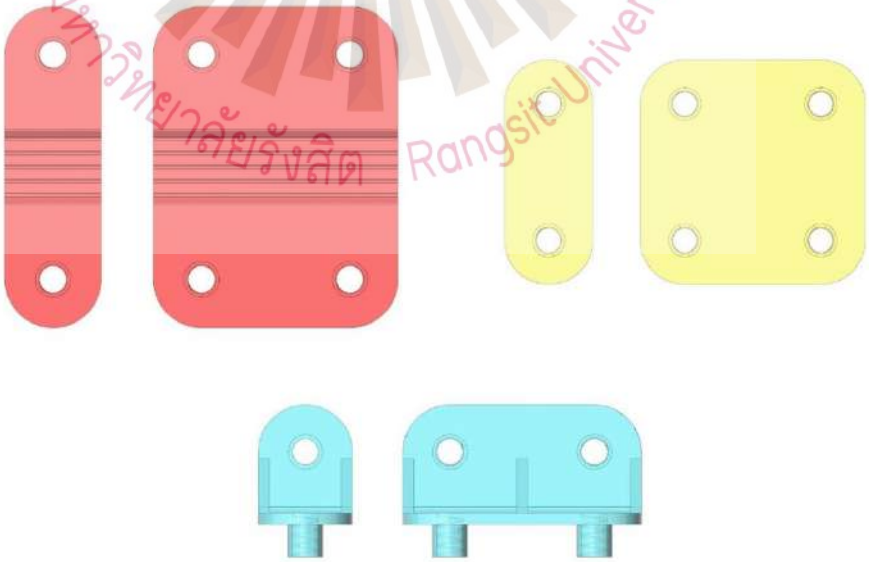


Figure 3.25 Connectors top view (3D model).

3) Experiment With 3D Printing of Connectors

The researcher has experimented with 3D printing of the connector, especially the hinge, there will be steps from printing methods including different materials for strength that can be used in practice as shown in Figure 3.26, 3.27 and 3.28

3.1) Plastic material type PLA in the technique of printing horizontally.

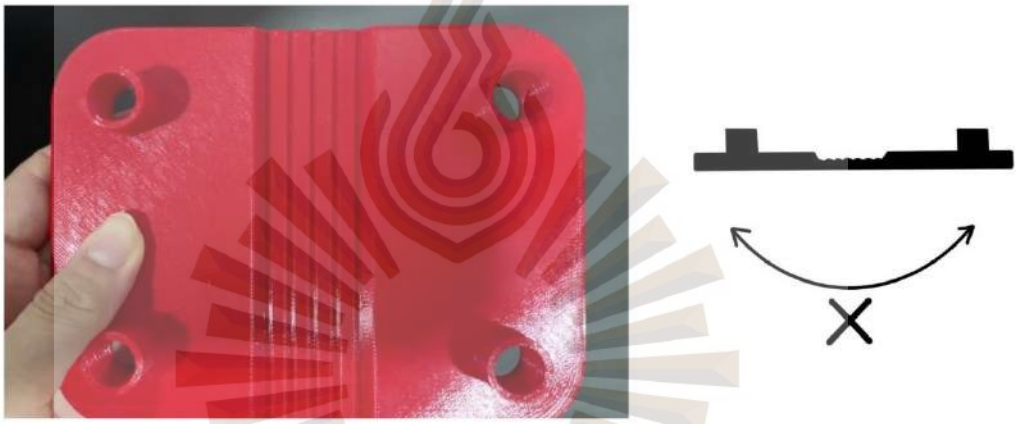


Figure 3.26 Experimental 3D printing techniques of connectors 01.

3.2) Plastic material type PLA in printing technique perpendicular to the base to make the structure of printing lines more frequency and resolution.

Figure 3.27 Experimental 3D printing techniques of connectors 02.

3.3) Plastic material type PET in the technique of printing perpendicular to the base to make the structure of the printing line more frequency and resolution.

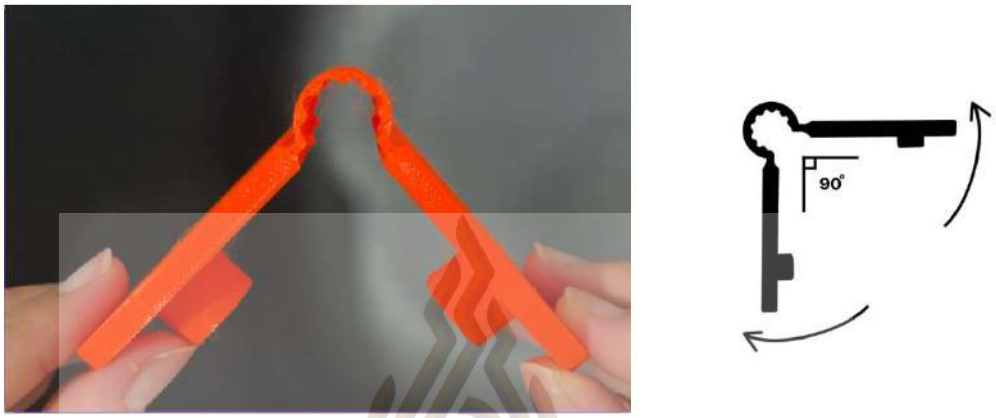


Figure 3.28 Experimental 3D printing techniques of connectors 03.

Collection of results of the experimental 3 D printing technique of the connector that it was evaluated in terms of strength characteristics that could not be broken with bare hands. The flexibility of the material, can be folded, and finally can be used for real by the evaluation scores are divided into very low (0-1 points), low (2 points), medium (3-4 points) or high (≥ 5 points) as shown in Table 3.2 below.

Table 3.2 Summary of the experimental 3D printing technique of the connector

No.	Material	Technique of Printing	Can't be broken by hand	Flexible	Can be folded	Sum
1	PLA	Horizontally	4	0	0	4
2	PLA	Perpendicular	3	2	2	7
3	PET	Perpendicular	4	5	5	14

Summary of experimental results from table 3.2, It was found that 3 D printing using a perpendicular method and using PET materials that are hard, resistant to breaking by hand, high flexibility, can be folded are suitable for practical use.

3.6.4 Decoration Part

As for the decorative parts, there are various appearances. and can also be disassembled by itself or assembled with other parts with different textures for each design and being able to feel the material, which contributes to stimulating the senses well, including the use of bright colors to stimulate imagination and creativity.

Figure 3.29 Decoration Part (3D model)

3.7 Final Prototype

Figure 3.30 Final prototype 01

Figure 3.31 Final prototype 02

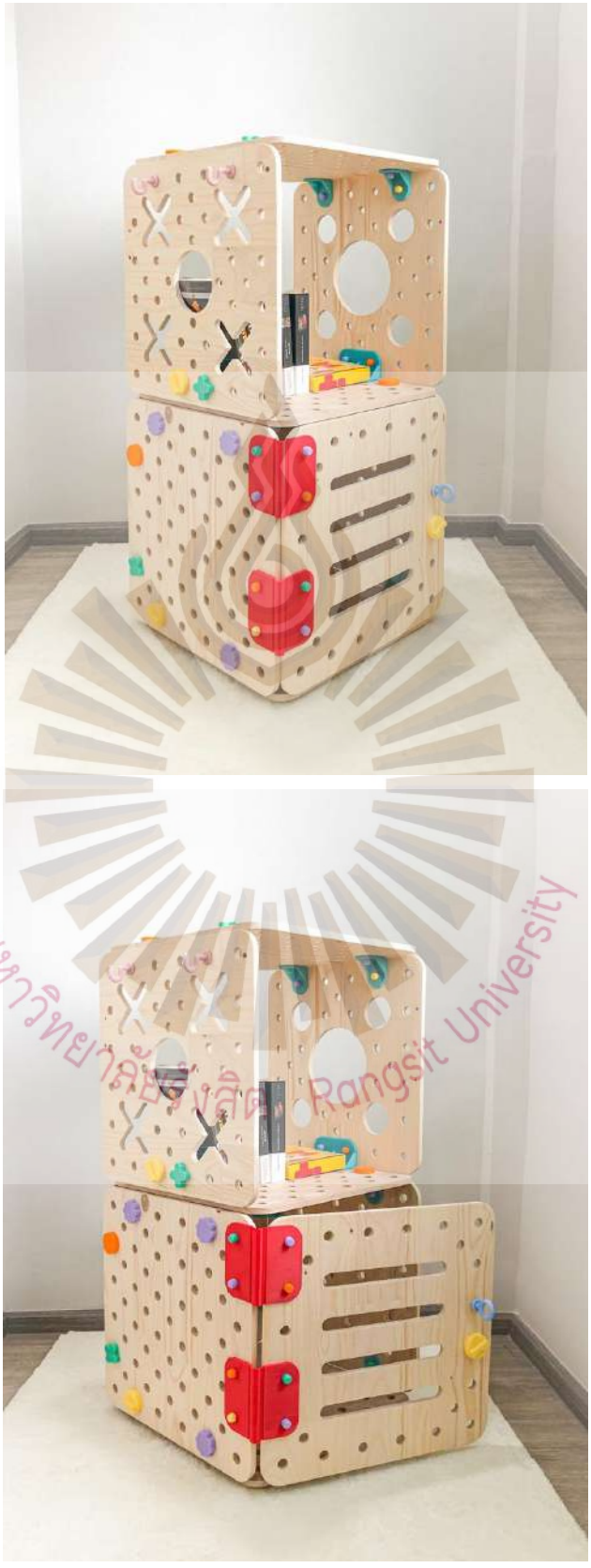


Figure 3.32 Final prototype 03

Figure 3.33 Final prototype 04

Screws (3D Model Printing)

Figure 3.34 Final prototype 05

Screws and connectors (3D Model Printing)

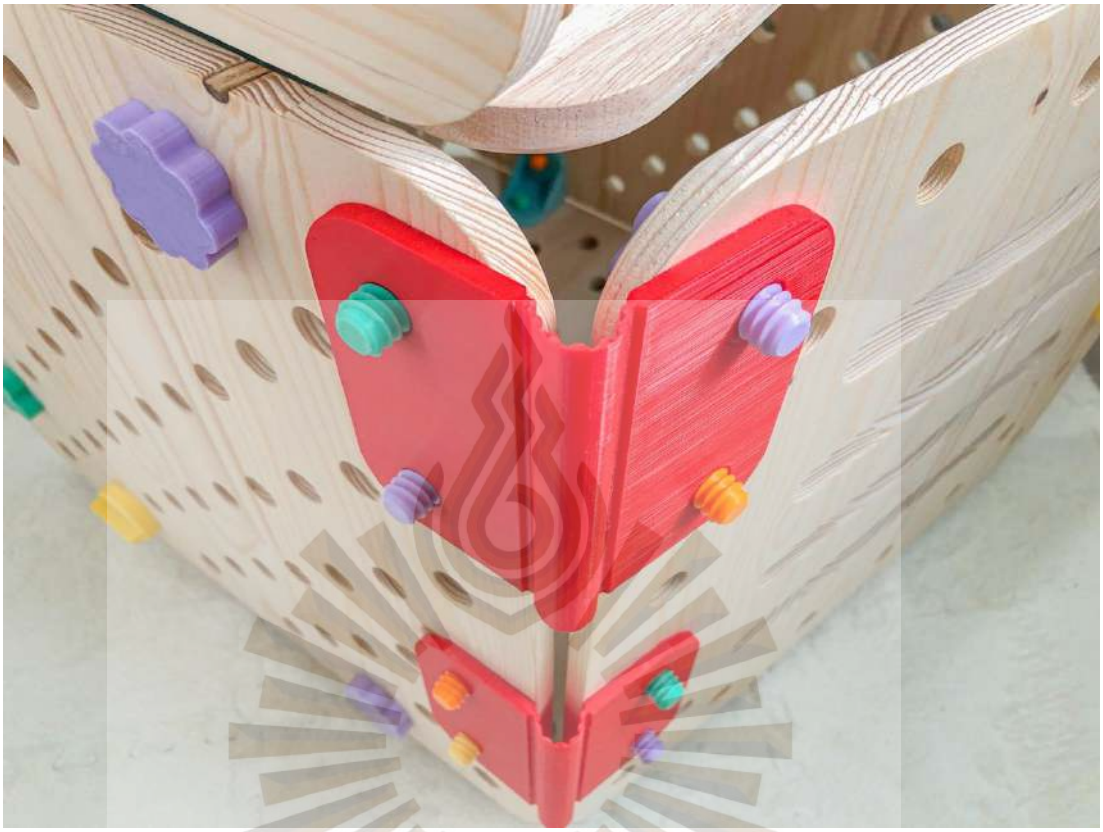


Figure 3.35 Final prototype 06

Figure 3.36 Final prototype 07

Figure 3.37 Final prototype 08

Chapter 4

Research Results

The ways of possible results from using this tool can be divided into 3 ways: as shown in Figure 4.1, 4.2 and 4.3

4.1 Result 1

Children can unleash their imagination and creativity through this tool set by being able to create ways to use and design a child's own way of playing.

Figure 4.1 Simulate an assembly example that is possible using a 3D program 01

4.2 Result 2

The fact that children who have assembled this set of tools to a large size increases the benefits of playing even more.

Figure 4.2 Simulate an assembly example that is possible using a 3D program 02

4.3 Result 3

Children can take this set of tools to expand their practical use and benefit more widely, an example of assembly work.

Figure 4.3 Simulate an assembly example that is possible using a 3D program 03

In this research, the researcher summarized the research results and discussion according to the objectives in the following order.

1) To study the factor to stimulate imagination and creativity.

As Guilford (1967) claims, the elements of creativity that are (1) Fluency, (2) Flexibility in thinking, (3) Initiative and (4) Elaboration including the research on 50 factors of effective factors in children's creativity (Azeri et al., 2015) suggests that the most contributing factor to children's creativity is Motivation to play Therefore, the researcher agrees that this research should be presented in the form of a tool that helps to influence the creation of objects to produce new and diverse results.

2) To study the design process of tools that promote the development of the imagination and creativity.

From the review of the literature, the researcher has come up with two main design concepts: There is a wide range of duties that can be used widely, and the system of the play must be too simple, which will allow the child to quickly bring out then creativity and using attractive colors for encouraging them to develop imagination Including hands-on experience with real materials for children to understand and deal with real situations by using this tool to satisfy and catalyst their creativity and imagination in a variety of ways.

Chapter 5

Conclusion and Recommendations

5.1 Conclusion

In this research, factors that promote imagination and creativity were studied to study how to promote imagination and creativity in children. By the way, the researcher has designed a set of tools for children aged 6 years or more to be able to disassemble this tool freely, with a method that is easy to understand, not too complicated so that children can quickly express their creativity and imagination. There are 3 parts in this set of tools: 1. Wooden panel, 2. 3 Types of connectors and 3. 7 Different of screws shape. And the researcher has made suggestions divided into 2 parts as follows.

1) Suggestions for use

1.1) As for the panel made of pine wood material, which has properties that are lightweight, safe for children, but not resistant to dropping or scratching, still need to be further developed in terms of material durability.

1.2) As for the hinge type connector, if it is used for a long time, there is a chance of breaking, so the hinge still needs to be developed in terms of stiffness and flexibility.

1.3) Should study more about materials that are safe for children.

2) Suggestions for further research

2.1) There should be more education on more diverse and independent connection systems that will result in children expressing their imagination and creativity in a greater variety.

2.2) There should be additional experiments on actual use in children of each age group to study the suitability of use in children in each age groups.

5.2 Recommendations

5.2.1 There should be more education on more diverse and independent connection systems that will result in children expressing their imagination and creativity in a greater variety.

5.2.2 There should be additional experiments on actual use in children of each age group to study the suitability of use in children in each age groups.

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